

Handout for Attendees
AAPM Annual Meeting
Houston, TX, July 30, 2008

CT Coronary Angiography: Indications, Radiation Dose, and Estimated Cancer Risk

Andrew J. Einstein, MD, PhD

Assistant Professor of Clinical Medicine
Cardiology Division, Department of Medicine
Department of Radiology
Columbia University Medical Center
andrew.einstein@columbia.edu

Educational Objectives/Talk Overview

1. Understand the information provided by CTCA, in comparison to other cardiac imaging modalities.
2. Know typical organ and effective doses from CTCA.
3. Learn how cancer risk attributable to CTCA depends on age and gender.
4. Understand approaches to lower radiation dose and cancer risk from CTCA.

1. Understand the information provided by CTCA, in comparison to other cardiac imaging modalities.

CTCA Plusses

- Non-invasive
- High spatial resolution
- Short Test (30 minutes in and out the door)
- Does not require serial cardiac enzymes in patients with acute chest pain
- High negative predictive value
- Assess non-flow limiting stenoses
- Assess plaque characteristics
- Acquires a volumetric data set that can be viewed in any plane and with multiple reconstructions
 - Besides from coronary anatomy, can assess LV function and wall motion, and extra-cardiac causes of chest pain

CTCA Minuses

- Requires ability to hold breath and follow instructions
- Need for heart rate control in many patients
- Poor image quality with arrhythmia
- Small but growing evidence base
- Iodinated contrast dose 50-120 cc
- Ionizing radiation exposure to patients

My Top 10 CTCA Indications for 2008

1. Symptoms, low-to-intermediate pretest probability of coronary disease: exclude coronary disease
2. Equivocal stress test
3. Emergency department chest pain patients
4. Evaluate for anomalous coronaries

5. Pulmonary vein assessment before atrial fibrillation ablation
6. Coronary vein assessment before biventricular pacemaker
7. Congenital heart disease
8. New onset heart failure
9. Before redo coronary artery bypass surgery
10. Assess coronaries before aortic valve surgery in aortic stenosis

2. Know typical organ and effective doses from CTCA.

4 ways to estimate dose

1. Measurements in physical phantom
2. From Dose-Length Product reported on scanner console, multiplied by $0.017 \text{ mSv} \cdot \text{mGy}^{-1} \cdot \text{cm}^{-1}$
3. Measurements in anthropomorphic phantom
4. From Monte Carlo Simulations

Organ Equivalent Doses

Highest: Thymus > Breast > Lung > Esophagus

See Table 1 in Einstein AJ et al. JAMA 2007;298:317.

Effective Doses

Helical: Doses in literature range from 8-21 mSv for 64-slice CTCA without tube current modulation. Literature tabulated in Einstein AJ et al, Circulation 2007;116:1290

Axial: 6 papers in 2008. Range 2-7 mSv.

3. Learn how cancer risk attributable to CTCA depends on age and gender.

Estimated using twofold approach:

1. organ doses estimated by Monte Carlo software
2. cancer risk using BEIR VII models (U.S. National Academies, 2006)

Findings varying depending on patient age, gender, and scan protocol:

1. Higher age, lower risk
2. Women have higher risk
3. Tube current modulation decreases risk by a third.
4. Higher risk if full aortic scan included.
5. Cancer risks of standard scan range from 1 in 143 (20 year old women) to over 1 in 3000 (80 year old men)

Reference: Einstein AJ et al. JAMA 2007;298:317

4. Understand approaches to lower radiation dose and cancer risk from CTCA.

- Only perform indicated studies
- Employ ECG-controlled tube current modulation when possible (low heart rate, regular rhythm)
- Consider prospective gating of CTA, with caveats
- Consider 100 kVp for thin patients
- Use β -blockers to lower heart rate, which improves efficacy of ECG-controlled tube current modulation
- Minimize scan length
- Match tube current to patient habitus
- Consider avoidance of CTA if calcium scoring scan reveals widespread, heavy coronary calcification
- Prospectively gate calcium scoring scan