THE CHANGING ROLE OF CARDIAC CT AS RADIATION DOSES DECLINE

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The increasing utilization of medical imaging for both screening and diagnosis has focused more attention on the potentially harmful effects of initial and potentially cumulative radiation exposure. CT vendors and researchers have responded with a variety of strategies for reducing the radiation dose required for a Cardiac CT Angiography. While the dose has remained essentially unchanged for other cardiac imaging modalities (such as a nuclear stress test) these new techniques for Cardiac CTA mean that many patients can be evaluated at extremely low doses. As the radiation dose of a Cardiac CTA approaches that of common screening studies such as Mammography, it is raises the question of whether CTA will eventually replace other modalities as the primary diagnostic or screening cardiovascular study?

Unfortunately, the debate over the role of CTA and radiation exposure is hampered by a paucity of meaningful data. It is difficult to extrapolate high dose or sustained exposures in a large population to short bursts of low dose exposure in an individual such as occurs with a CT Scan. Even in the absence of agreement on the actual risk posed by medical imaging, it is widely accepted that the risk is increased for younger patients who have a longer time frame in which the carcinogenic effects of radiation can become apparent. Patients who undergo repetitive testing may be likely to accumulate lifetime doses that will also pose an increased risk. Patients with coronary artery disease are likely to fall into both these categories with disease commonly requiring treatment by the fourth decade of life and persisting over many subsequent decades. In that case, minimizing the lifetime cumulative exposure related to cardiac testing is likely to improve the risk-benefit ratio.

Depending on the parameters of a Cardiac CT Angiography Scan, the radiation dosage has generally ranged from about 6 mSv to as much as 30 mSv per scan. Many clinicians are surprised to learn that the radiation dose associated with other cardiac testing modalities is comparable to or greater than Cardiac CTA. A diagnostic catheter angiography typically will range from 4 to 15 mSv. A dual-isotope nuclear stress test is likely to expose the patient to 10-25 mSv. Most of that radiation will be to more radio-sensitive tissue and be of longer duration than from a CT Scan. This raises the concern that a common scenario such as a patient with an equivocal stress test that leads to a CTA and then a catheterization could easily be exposed to as much as 25-60 mSv of radiation in a very short time frame.

CT Manufacturers have made tremendous progress in strategies for reducing CTA radiation dose. The most significant of these has been the increasing use of prospective gating. Increasing the number of detector rows, such as 256 or 320 detector row scanners, also reduces radiation exposure by reducing or eliminating table pitch and the need to scan each segment of the anatomy more than once. Various software-based algorithms that can modulate the X-ray tube current can further decrease X-ray dose. When combined with careful attention to the scan parameters (including heart rate control, using lower kV in thinner patients, limiting the length of the scan, etc.) it is becoming increasingly common to be able to acquire a high quality Cardiac CT Angiography with doses below 3 mSv. In select cases, it is even possible to perform the scan with less than 1 mSv of radiation. Radiation doses below 1 mSv are comparable to naturally occurring sources of radiation exposure and are likely to contribute a negligible amount to cumulative lifetime doses. Doses in this range could effectively remove radiation exposure from the debate over the role of Cardiac CTA.

The spatial and temporal resolution of Cardiac CT Angiography remains inferior to that of catheter angiography, making it likely that catheter angiography will continue to be the “gold standard” for defining the severity of plaque for some time to come. However, CT Angiography

has approximately a 99% Negative Predictive Value for " non-obstructive" coronary stenoses, which are conventionally <50% narrowing of the lumen, making it highly effective at determining which patients are unlikely to be symptomatic on the basis of coronary artery obstruction. The absence of detectable plaque by CT has also been shown to indicate a very low cardiac event risk, obviating the need for additional testing and aggressive treatment. As low-dose CTA becomes increasingly common, it is likely to become the most radiation-effective and cost-effective means for determining the work-up of patients with suspected or known coronary artery disease.

A Cardiac CT can quickly and accurately determine if detectable plaque is absent. Patients with zero calcium scores and no non-calcified plaque seen on CTA are unlikely to require any further testing for coronary atherosclerosis or stenotic disease. Patients who have non-zero calcium scores but clearly do not have obstructive disease on CTA may require medical therapy but also have little benefit from further evaluation with stress testing or catheterization. Patients with high grade disease or equivocal results from CT Angiography should be further evaluated with perfusion imaging or catheter angiography as clinically warranted.

Application of such a clinical algorithm would likely result in a marked overall decrease in radiation exposure. Patients who currently are first evaluated with a nuclear stress test can be triaged by Calcium Score and CTA with less radiation and lower cost, allowing the vast majority of patients to avoid further testing and radiation entirely. Patients with high risk symptoms or scans suggestive of obstructive disease might bypass stress testing entirely and go directly from the scanner to the angiography lab. The role of nuclear stress testing may diminish even further as new scanners approach the goal of providing useful information on myocardial perfusion.

A recent survey published by the market research firm IMV Medical Information Division cited concern by cardiologists over "generating adequate patient volumes" as a major factor in their decisions about whether or not to incorporate CT into their practices. As the cost and radiation dose of Cardiac CT continues to decline, the bigger issue for cardiologists may be "What do we do now with those nuclear cameras now that everything is done by CTA?"