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Commentary

Significance of Imaging Coronary Artery Disease

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DESCRIPTION

The effective radiation dosage applied in a nuclear myocardial perfusion scan is fundamentally contingent on the procedure chosen for the specific patient and the tracer or radiopharmaceutical agent employed for the assessment. Because there is no locally fixed source of ionizing radiation used in this setting, estimating the radiation dose for a nuclear scan becomes even more difficult: in fact, the estimation is performed by compiling different dose coefficients determined by biokinetic models quantifying the distribution and metabolism of ionizing agents in the (human) body. These models make use of organ and radionuclide-specific activity data throughout time, as well as data on energy absorption in specific target organs.

Nonetheless, some assumptions on radiation exposure of nuclear studies can be made. However, according to the most recent American Society of Nuclear Cardiology guidelines, levels for a 99mTc sestamibi stress/rest protocol should be around 11 mSv, while levels for a 201Tl stress/reinjection protocol should be around 32 mSv. As a result, the effective dosages utilized in nuclear techniques-based cardiac perfusion studies are far from simple and vary widely: Single-injection techniques produce the lowest dose estimates, while dual-isotope studies, which are frequently used in outpatient settings, typically produce the highest effective dose estimates of about 29 mSv.

The lowest doses may be obtained utilizing positron emission tomography procedures that use 13N ammonia and 15O water, with estimated dose levels of 2.4 and 2.5 mSv. Although the estimated dose for nuclear techniques appears to be relatively high, there are few options for reducing the radiation burden in these studies: the most obvious is the use of stress-first or even stress-only scanning protocols for selected patients with a low pre-test probability of coronary artery disease. Regrettably, only 9% of nuclear cardiology facilities in the United States provide single-injection procedures, and only 4% of nuclear investigations employ a single-injection protocol using a 99mTc agent.

Coronary Computed Tomography Angiography (CTA) is the most newly developed technology in coronary heart imaging. However, its use in clinical practises has been hampered not only by the ongoing funding issue, but also by data indicating that the radiation dosage associated with a coronary CTA examination is potentially considerable. In reality, there has been a paucity of data on radiation dosage estimates for cardiac CT. The range of median radiation dose estimates reported in this study, which ranges from 5 to 30 mSv, is remarkable because it reflects a phenomenon that can be observed in both nuclear and conventional coronary angiography: estimated effective doses vary greatly regardless of the imaging technique used. Yet, it can be mentioned that there are extremely effective ways to significantly lower the dose for coronary CTA. These include, "ECG pulsing" or electrocardiographically controlled tube current modulation, "100 kV scanning protocols" which are used on non-obese patients, and even "sequential scanning" which involves prospective ECG-triggering and is used on patients with stable and infrequent sinus rhythms.

Studies could show that these techniques have the potential to significantly reduce the estimated dose to less than 4 mSv in patients routinely examined with a 100 kV protocol and retrospectively gated coronary CTA, or even to 2.1 mSv or lower in patients examined with prospectively ECG-triggered coronary CTA. Also, the PROTECTION I study might prove that implementing dose-saving algorithms has no discernible effect on image quality. Yet, there is one significant restriction to these effective techniques: Just 73% of the Phase I population was studied with ECG-pulsing, and the subgroups of patients receiving coronary CTA with a 100 kV protocol or prospective ECG-triggering were significantly smaller: 5 and 6%, respectively. This demonstrates that, despite the fact that there are several ways for reducing radiation exposure in coronary CTA, very few investigators are aware of how to use them.

CONCLUSION

The amount of radiation that patients are exposed to varies dramatically not just across different cardiac imaging modalities, but also between different protocols of the same imaging technology. While dose in conventional coronary angiography is heavily influenced by factors such as operator experience and procedural complexity, it varies with different tracers in nuclear imaging and with the simple and effective implementation of

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dose-saving scanning techniques in coronary CTA for selected patients. Although while the effect of a specific ionizing radiation exposure may be exceedingly difficult to establish, it should be highlighted that careful attention to methodology, including the use of dose-reduction measures, can decrease dosage to patients as well as investigating personnel.