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Editorial

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Potential of Calcium Scoring CT to Identify Subclinical Coronary Artery Disease in Patients with Prior Thoracic Irradiation

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▸ See the article "Coronary Artery Dose-Volume Parameters Predict Risk of Calcification After Radiation Therapy" in volume 27 on page 268.

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Conflict of Interest
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Radiation therapy (RT) is an important treatment option for various thoracic malignancies.[1)] However, the use of thoracic irradiation is a double-edged sword as it may result in substantial cardiac complications. Notably, cardiovascular disease is the most common non-malignant cause of death in patients with Hodgkin lymphoma and breast cancer who receive treatment with RT.[1)] Cardiac complications can involve any of the cardiac structures including the pericardium (acute or chronic pericarditis), coronary arteries (coronary artery disease), valves (valvular heart disease), conduction system (various conduction abnormalities), and myocardium (systolic and diastolic cardiomyopathy) often manifesting in the second or third decade after RT (i.e., a long term complication). Not surprisingly, cardiac complications occur often in patients with conventional cardiac risk, higher total dose (> 30-35 Gray), higher dose per fraction (> 2 Gray/day), younger age at exposure (< 20 years of age), longer time after irradiation exposure, use of cardio-toxic chemotherapy (e.g., anthracycline), and type of irradiation technique.[1-3)] One intriguing finding was reported in a study that showed an increased long-term risk of cardiac death (odds ratio = 1:56, 95% confidence interval: 1.27 to 1.90) in patients with left breast cancer treated with radiotherapy as compared with right-sided breast cancer. This is presumed due to the closer proximity of the irradiation field to the heart in left breast therapy.[4)]

Radiation can damage any of the cells within the heart including the vasculature due to its production of free oxygen radicals. In this context, coronary artery stenosis occurs by means of intimal proliferation and intimal damage. One previous study reported that significant coronary artery disease occurred in 10.4% (43/415) of patients who underwent RT for Hodgkin's lymphoma at a median of nine years follow-up.[5)] Although it is difficult to differentiate RT related coronary plaque from atherosclerotic coronary plaque, the former tends to have more fibrotic and less lipid components. It is also known that coronary ostial stenosis (e.g., the left main and right coronary artery) is a feature of radiation induced coronary artery disease.[1)] Several RT-related strategies are available to reduce cardiac complications, such as deep inspiration breath holding, and multi-leaf collimator technique for breast cancer.[1)6)]

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In a study reported in this issue, Milgrom et al.[7] found that higher radiation exposure in the coronary arteries is significantly associated with presence and extent of coronary artery calcification on calcium scoring CT after a median follow-up of 32 months, even after controlling conventional risk factors for coronary artery disease. The authors used a 3D technique for the measurement of specific irradiation dose in the coronary arteries instead of crude mean heart dose. The authors also suggest that calcium scoring CT may have potential to be used as a screening tool in patients with high risk for radiation induced coronary artery disease.

However, there are several important points that should be mentioned including a number of limitations, some of which the authors mention. First, the study results are limited by the small number (n = 20) of enrolled patients leading to potential selection bias, and less than optimal statistical power. Second, the authors did not include an age-sex-matched control group in the study. Third, the authors did not perform subgroup analysis based on whether anthracycline, a risk factor for coronary artery disease after RT was used (n = 9). Fourth, the authors used SCCT guidelines for classification of coronary calcification on non-gated pre-RT CT (i.e., lack of pre-RT calcium scoring CT).[8] However, the grading with this method is subjective. What would be an objective differential point between grade 1 and 2, or 2 and 3 using this system? Moreover, different CT protocols were used between pre-RT non-gated CT and ECG-gated calcium scoring CT in the study. For example, 2.5-5 mm and helical mode was used for pre-RT vs 2.5 mm slice thickness and axial mode for the post-RT CT, respectively. Given such substantial differences between pre- and post-RT CT protocols, a one-to-one comparison may not be entirely valid. Notably, tiny amounts of coronary calcification on non-gated CT using a thicker slice can be misinterpreted as an absence of calcification due to partial volume averaging.[9] This is important because the major change shown in the study was conversion of zero calcium score into positive coronary calcium score involving only one coronary artery (i.e., conversion from CAC-DRS V0N0 to CAC-DRS V1N1). Fifth, the radiation field was inhomogeneous among the patient cohort due to inclusion of various thoracic malignancies (breast cancer, lymphoma, multiple myeloma, and lung cancer) in the study. Such inhomogeneity may make it difficult to state with confidence the association between RT dose and extent of coronary artery calcification because of differing exposures to the coronary arteries. Lastly, noncalcified plaque often precedes calcified plaque in the development of coronary atherosclerosis. Importantly, a majority of acute myocardial infarction is caused by rupture of vulnerable plaque. Only coronary CT angiography can be used noninvasively to evaluate vulnerable plaque morphology, not calcium scoring CT.[9] However, the authors have done a service by highlighting the potential role of calcium scoring CT to assess the risk of developing atherosclerotic coronary artery disease in asymptomatic patients with prior thoracic irradiation which is not well-investigated.[10] Further studies are required to address the role of calcium scoring CT in evaluating this association (e.g., when and how often calcium scoring CT should be performed to identify subclinical coronary artery disease in patients with history of thoracic irradiation?).

REFERENCES

1. Jaworski C, Mariani JA, Wheeler G, Kaye DM. Cardiac complications of thoracic irradiation. *J Am Coll Cardiol* 2013;61:2319-28.
PUBMED | CROSSREF

Journal *of* Cardiovascular Imaging JCVI

2. Byrd BF 3rd, Mendes LA. Cardiac complications of mediastinal radiotherapy. The other side of the coin. *J Am Coll Cardiol* 2003;42:750-1.
PUBMED | CROSSREF

3. Tötterman KJ, Pesonen E, Siltanen P. Radiation-related chronic heart disease. *Chest* 1983;83:875-8.
PUBMED | CROSSREF

4. Bouillon K, Haddy N, Delaloge S, et al. Long-term cardiovascular mortality after radiotherapy for breast cancer. *J Am Coll Cardiol* 2011;57:445-52.
PUBMED | CROSSREF

5. Hull MC, Morris CG, Pepine CJ, Mendenhall NP. Valvular dysfunction and carotid, subclavian, and coronary artery disease in survivors of hodgkin lymphoma treated with radiation therapy. *JAMA* 2003;290:2831-7.
PUBMED | CROSSREF

6. Welsh B, Chao M, Foroudi F. Reducing cardiac doses: a novel multi-leaf collimator modification technique to reduce left anterior descending coronary artery dose in patients with left-sided breast cancer. *J Med Radiat Sci* 2017;64:114-9.
PUBMED | CROSSREF

7. Milgrom SA, Varghese B, Gladish GW, et al. Coronary artery dose-volume parameters predict the risk of calcification after radiation therapy. *J Cardiovasc Imaging* 2019;27:268-79.
CROSSREF

8. Hecht HS, Blaha MJ, Kazerooni EA, et al. CAC-DRS: Coronary Artery Calcium Data and Reporting System. An expert consensus document of the Society of Cardiovascular Computed Tomography (SCCT). *J Cardiovasc Comput Tomogr* 2018;12:185-91.
PUBMED | CROSSREF

9. Kim HR, Yoo SM, Rho JY, Lee HY, White CS. MDCT evaluation of atherosclerotic coronary artery disease: what should radiologists know? *Int J Cardiovasc Imaging* 2014;30 Suppl 1:1-11.
PUBMED | CROSSREF

10. Rademaker J, Schöder H, Ariaratnam NS, et al. Coronary artery disease after radiation therapy for Hodgkin's lymphoma: coronary CT angiography findings and calcium scores in nine asymptomatic patients. *AJR Am J Roentgenol* 2008;191:32-7.
PUBMED | CROSSREF