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Subclinical Carotid Atherosclerosis and Early Vascular Aging From Long-Term Low-Dose Ionizing Radiation Exposure

A Genetic, Telomere, and Vascular Ultrasound Study in Cardiac Catheterization Laboratory Staff

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CME Objective for This Article: At the completion of this article, the learner should be able to: 1) discuss clinical manifestations that may be related to chronic low dose radiation exposure; and 2) understand the connection between radiation exposure and subclinical atherosclerosis.

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Subclinical Carotid Atherosclerosis and Early Vascular Aging From Long-Term Low-Dose Ionizing Radiation Exposure

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ABSTRACT

OBJECTIVES This study sought to assess the association between long-term radiation exposure in the catheterization laboratory (cath lab) and early signs of subclinical atherosclerosis.

BACKGROUND There is growing evidence of an excess risk of cardiovascular disease at low-dose levels of ionizing radiation exposure.

METHODS Left and right carotid intima-media thickness (CIMT) was measured in 223 cath lab personnel (141 male; age, 45 ± 8 years) and 222 unexposed subjects (113 male; age, 44 ± 10 years). Leukocyte telomere length (LTL) was evaluated by quantitative reverse transcriptase polymerase chain reaction. The DNA repair gene *XRCC3* Thr241Met polymorphism was also analyzed to explore the possible interaction with radiation exposure. The occupational radiological risk score (ORRS) was computed for each subject on the basis of the length of employment, individual caseload, and proximity to the radiation source. A complete lifetime effective dose (mSv) was recorded for 57 workers.

RESULTS Left, right, and averaged CIMTs were significantly increased in high-exposure workers compared with both control subjects and low-exposure workers (all p values <0.04). On the left side, but not on the right, there was a significant correlation between CIMT and ORRS ($p = 0.001$) as well as lifetime dose ($p = 0.006$). LTL was significantly reduced in exposed workers compared with control subjects ($p = 0.008$). There was a significant correlation between LTL and both ORRS ($p = 0.002$) and lifetime dose ($p = 0.03$). The *XRCC3* Met241 allele presented a significant interaction with high exposure for right side ($p_{interaction} = 0.002$), left side ($p_{interaction} < 0.0001$), and averaged ($p_{interaction} < 0.0001$) CIMTs.

CONCLUSIONS Long-term radiation exposure in a cath lab may be associated with increased subclinical CIMT and telomere length shortening, suggesting evidence of accelerated vascular aging and early atherosclerosis.
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Contemporary interventional cardiologists have an annual exposure radiation dose 2 to 3 times higher compared with diagnostic radiologists (1–4). Of special concern, the head organ dose is 10- to 20-fold higher than the whole-body dose recorded below the apron (2–5). Furthermore, the left side of the operator is more exposed than the right side in most cases due to the usual layout of an intervention suite, where the radiologist or cardiologist operates from the right side of the patient so that the scatter radiation comes predominantly from the patient on the radiologist's or cardiologist's left (2,3). The characterization of health risks of accumulated low-dose radiation is incomplete and largely lacking (6,7). The current system of protection against ionizing radiation mainly addresses the risk of cancer from the stochastic effects of prolonged low-dose exposure. At the present time, there is growing evidence of an excess risk of cardiovascular disease at both high- and low-dose levels of ionizing radiation exposure (8–11). However, the association between occupational dose levels (<500 mSv) and late cardiovascular risks is still controversial (8,11,12). There are several mechanisms by which ionizing radiation may

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affect vascular and cardiac function (11). A plausible hypothesis is that DNA damage caused by long-term exposure may accelerate vascular aging leading to atherosclerosis (11,13). We sought to assess the association between long-term radiation exposure in the cath lab and early signs of subclinical atherosclerosis as assessed by carotid intima-media thickness (CIMT) and leukocyte telomere length (LTL). In