

Fluoroscopy Operators' Brains and Radiation



The recent article by Reeves et al. (1) highlights concerns of many health care providers who work with fluoroscopy. The authors investigated the effect of wearing a radiation-attenuating cap on reducing radiation exposure to the brains of fluoroscopy operators. I was troubled, however, by the significant limitations of the study and the authors' oversimplification of this important issue.

Accurately measuring radiation is a necessary component of this study, yet the study fails to consider the appropriateness of the radiation detector used. The Laudauer nanoDots used in this study were calibrated to measure primary radiation from an 80-kVp diagnostic x-ray beam with a half value layer (HVL) of 2.9 mm of aluminum, which has significantly different physical properties than the scattered radiation being measured in this study.

More distressing, however, are the omissions made in discussing the biological effects of the radiation measured in this study. Taking into account the average thickness of the human skull (2), the spectrum of the scattered x-ray beam (3), and the x-ray attenuation properties of bone, one can estimate that ~40% of the scattered radiation is absorbed by the skull and never reaches the brain. Additionally, the tissue weighting factor for brain tissue is 0.01. (Compare this with the tissue-weighting factor of 0.12 of breast tissue.)

Finally, the authors leave out any discussion of the biological effects (or lack thereof) of the amounts of radiation measured in their study. The highest radiation exposure was measured on the left side of physicians' heads, outside the cap, an average of 1.02 mrad (or 10.2 μ Gy) per case above background. Taking into account the attenuation provided by the skull and the tissue-weighting factor of the brain, this equals a tissue dose of ~0.06 μ Sv. Data suggest that the vasculature in the brain may show damage at doses as low as 150 mSv (or 150,000 μ Sv). According to the study data, a physician could perform almost 2.5 million cases before the left side of the head is exposed to levels of radiation thought to be of risk.

Others have reported a prevalence of left-sided brain and neck tumors in interventional physicians (4) and acknowledged the limitations of these data. In recounting the data reported by Roguin et al. (4), important information is often left out, namely,

the bias of self-selection and a lack of comparison with brain and neck tumors in nonradiation workers. In fact, it has been demonstrated that among the general population, some tumors occur more frequently on the left side of the brain (5). Without these comparisons and context, the self-reported cases discussed in these previous papers are difficult to interpret.

The authors point out that wearing the cap reduces radiation exposure to the head by as much as a factor of 16. Although this sounds like a large dose reduction, 16 times a very small number is still a very small number. The bottom line here is that manufacturers of radiation-attenuating caps are basing their advertising on fear, not science.

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Please note: Dr. Marsh has reported that she has no relationships relevant to the contents of this paper to disclose.

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REPLY: Fluoroscopy Operators' Brains and Radiation



We appreciate the interest of Dr. Marsh in our publication regarding the cranial exposure to radiation scatter for operators during invasive cardiology procedures (1). The critique seems to be based on a misunderstanding of the study's design and objectives. The study was designed to measure the differential radiation exposure to various regions of the cranium during invasive cardiovascular procedures.

Optically stimulated luminescence (OSL) dosimetry is well established with operative principles identical to those of traditional thermoluminescence

dosimetry for radiodiagnostics (2). It has been used for personal dosimetry (as a replacement for film badges) and medical dosimetry for both radiotherapy and radiodiagnostics (2,3). The dosimeters (nanoDot, Landauer, Glenwood, Illinois) used in our study are OSL based, small ($1 \times 1 \times 0.2 \text{ cm}^3$), environmentally stable, and highly accurate and precise within the exposures measured in the study (3). Additionally, placing them under the XPF attenuating cap (BLOXR Corp., Salt Lake City, Utah) made them imperceptible to the research subjects and enabled comparative data assessment between cranial locations.

Although not a focus of this paper, the biological effects of long-term, low-dose radiation exposure including the stochastic and dose-dependent deterministic effects on health care workers are well established. In fact, Andreassi et al. (4) recently reported that workers exposed to high medical radiation in the cardiac catheterization laboratory had increased left-sided carotid intima-media thickness (CIMT) and reduced leukocyte telomere length. The presence of a specific polymorphism of the DNA repair gene XRCC3 Thr241Met, associated with increased chromosomal DNA damage in workers occupationally exposed to long-term ionizing radiation, was also found to be more prevalent in high-exposure workers and associated with increased CIMT (4). Although the risk of occupational radiation-induced brain malignancies has not been determined, this study (complete lifetime dosimetry reconstruction: occupational exposure, 12.6 ± 8.6 years; dose, $21.1 \pm 26.3 \text{ mSv}$) suggests that adverse vascular and subcellular effects exist for the left side of the head and neck region of operators at case volumes that are within routine practice and not 2.5 million.

The secondary objective of our study was to determine whether a light-weight cap (nonlead based) could help *attenuate* the cranial radiation exposure to near ambient levels. The studied cap met those objectives, and its use would be consistent with the fundamental radiation safety principle of keeping medical radiation “as low as reasonably achievable.”

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Does Direct Transcatheter Aortic Valve Replacement Increase the Risk of Cerebral Embolization?



We read with great interest the paper by Bijuklic et al. (1) that reported an increased risk of cerebral embolization with direct transcatheter aortic valve replacement (TAVR) without preceding balloon aortic valvuloplasty (BAV) using a balloon-expandable TAVR system.

Although this is a thought-provoking study, we feel that there are several issues. This is a small, retrospective series, and the 2 groups are not well-matched. The direct TAVR group consists entirely of S3 valves, whereas the BAV group were mostly Sapien XT valves. These 2 valves have different characteristics: for instance, the S3 valve has a smaller sheath and delivery system, which increases the proportion of patients who can be treated by the transfemoral approach and means that the cohort of patients treated may be different. To support this theory, there were higher rates of atrial fibrillation, diabetes mellitus, and hypertension in the direct group, which are important risk factors for stroke. The 13 S3 patients in the BAV group had small valve areas or valve calcium, which will introduce selection bias. The authors do not report differences in valvular calcification.

We also feel that Figure 1 requires further clarification. These data represent the most important results of the paper, but it is only represented in chart form, and the data are not included in the *Results* section. It is also not clear whether the error bars represent standard deviation or standard error of the mean. Furthermore, the error bars are missing from chart A.