Physical Health and Radiation Exposure for the Practitioner

Understanding radiation overexposure effects, standard dose thresholds, and necessary steps to ensure safety.

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The number and complexity of endovascular interventions are increasing. Vascular surgeons and interventionalists today are exposed to more ionizing radiation than previous generations, and it is crucial to recognize the short- and long-term risks of radiation exposure. Practitioners must understand the deleterious effects of overexposure, know the standard occupational and patient dose thresholds, and be cognizant of ways to minimize dose exposure during endovascular procedures.

EFFECTS OF OVEREXPOSURE

Radiation causes two types of biologic injury: stochastic and deterministic. Stochastic effects, namely cancer formation, increase with the total radiation energy absorbed over time. Deterministic effects, which require a threshold dose, are most commonly skin injuries in patients and cataracts in interventionalists. Although these effects are infrequent, they can be devastating and should be suspected at specific dose thresholds.

OCCUPATIONAL AND PATIENT DOSE THRESHOLDS

The International Commission on Radiological Protection recommends an occupational effective dose limit and an ocular lens dose limit of 20 mSv averaged over 5 years, with no more than 50 mSv in a single year.[1] Most personnel dosimeters are read monthly; however, understanding the fluoroscopic dose metrics, which are available in real time, can help providers gauge how much radiation they are exposed to daily. In general, fluoroscopy time is a poor indicator of overall dose because it eliminates the radiation that accrues from digital acquisitions. Reference air kerma (RAK) is the best approximation of patient skin dose because it measures the radiation dose at a constant reference point at the patient's level. The National Council on Radiation Protection and Measurements has defined RAK ≥ 5 Gy as a substantial patient radiation dose level.[2] At this dose, the patient should be informed of the exposure and followed prospectively for skin injury. Kerma area product measures the total output of the x-ray tube and has been shown to be a better predictor of operator dose than RAK.

MINIMIZING EXPOSURE

Scatter radiation from the patient is the principal source of operator exposure. With appropriate training, interventionalists can minimize this radiation dose. The key to protecting yourself and your operating room team is to follow the basic principles of time, distance, and shielding. Surgeons should use low-dose fluoroscopy modes, lower the frame rates, and be mindful of active fluoroscopy times. Avoiding magnification views and steep gantry angulations can also lower dose, and using the collimators narrows the beam and associated scatter radiation. Operators should wear lead shielding and step away from the x-ray tube whenever possible. Radiation adheres to the inverse square law: increasing your distance from the source by a factor of two decreases your radiation by a factor of four. In addition to these basic principles, keeping the fluoroscopy unit current with new dose-lowering software can significantly limit dose.

CONCLUSION

As the breadth of endovascular procedures increasingly evolves, interventionalists and vascular surgeons must continuously emphasize the importance of radiation safety to protect patients, trainees, and team members. ■

1. Dauer LT, Ainsbury EA, Dynlacht J, et al. Guidance on radiation dose limits for the lens of the eye: overview of the recommendations in NCRP commentary no. 26. Int J Radiat Biol. 2017;93:1015-1023.
2. National Council on Radiation Protection and Measurements. NCRP report no. 168, radiation dose management for fluoroscopically-guided interventional medical procedures. https://ncrponline.org/publications/reports/ncrp-report-168. Accessed December 6, 2019.

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