

Proper Shielding Technique in Protecting Against Scatter Radiation

Lloyd W. Klein, MD

The University of California, San Francisco, Cardiology Section, San Francisco, California

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Radiation shielding can provide effective protection from scatter radiation during vascular angiographic procedures. However, the individual shields must be carefully arranged if optimum protection is to be achieved.¹ Although proper positioning is voluntary, the occupational hazards of unnecessary exposure affect the health of the entire staff in the working environment. Consequently, its effectiveness varies because its employment is operator-dependent.²⁻⁴ The operator is required to coordinate the placement of the x-ray tube, the image detector, and ceiling and table-mounted shields to protect colleagues for the health effects of scatter radiation.

The principal source of radiation exposure to interventional physicians and fluoroscopy suite staff is scatter radiation.^{3,4} Scatter radiation spreads in various directions when an x-ray beam interacts with objects, causing the x-rays to be dispersed. In the catheterization laboratory, the patient's body deflects radiation, causing it to distribute around the room. Operators and staff are at highest risk consequent to their relative proximity to the patient and x-ray beam.

In a standard catheterization suite, the protective shielding will be a combination of movable shields suspended from the ceiling along with fixed table-side shields. This combination works to significantly reduce scatter radiation exposure.⁵

To further reduce operator exposure, it is important to minimize the area of the vertical gap between these shields where scatter radiation can "leak" through. The best protection from scatter radiation will be provided when the upper body shield is located relatively far from the scatter source and close to the physician, minimizing the effective size of the gap created by the patient contour cutout.³

The position most commonly taught is actually the least effective. Operators are traditionally taught to position the shield close to the image detector and x-ray tube, and directly next to the patient, which is farthest from the operator. The most effective position is to place the ceiling shield closer to the operator, which maximizes its radiation "shadow." In this way, the shield is placed as one would use an umbrella in wind-driven rain; that is, as close to the operator as possible.¹ When

correctly placed, shields provide at least 80% protection from scatter at all table elevations. To provide additional protection and further minimize the amount of scatter directed toward the physician, accessory soft extensions should be placed along the bottom edge of the upper body shield.

Maintaining effective protection during procedures sometimes takes low precedence.⁶ Because the upper body shield must be specifically placed by the physician and often is moved during the procedure, it must be continually readjusted. The upper body shield requires continual repositioning when the patient table height is adjusted, when the table is moved longitudinally or laterally, or when it must be moved to avoid collision with the x-ray system for steep caudal angles. This creates a sense of nuisance that must be consciously overcome; it is an annoyance to be concerned with it when our minds are focused on the patient. The most advantageous shield positioning can have a greater than 4-fold relative reduction in scatter radiation exposure, supporting its use even when inconvenient.

Learning to coordinate multiple shields should be among the fundamental principles taught in every vascular training program.⁷⁻⁹ Real-time dosimetry providing on-the-spot radiation exposure feedback has been used to motivate modifications in the use of shielding equipment available in the catheterization laboratory. Much more can be done practically to protect our colleagues once attention is called to the subject.

Making use of effective shielding is the best approach to managing exposure to radiation. Radiation shield protection products are lead-lined glass or latex/plastic. Shielding means placing something that will absorb radiation between the source of the radiation and the area to be protected. The concept of shielding is based on the principle of attenuation, which is the loss in intensity of a beam of radiation as it traverses through barrier material. Attenuation is the result of interactions between x-ray and matter from a combination of absorption and scatter. The differential absorption increases as peak kilovoltage (kVp) decreases.

Lead is particularly well suited for x-ray shielding material due to its high atomic number, which refers to the number of protons within an atom; a lead atom has a relatively high number of

protons along with a corresponding number of electrons. These electrons “block” the x-ray photons that are projected through a lead barrier by absorbing their energy. The degree of protection can be enhanced by using thicker shielding barriers. Because of the heavy weight of lead, layers of bismuth and some lightweight synthetic materials are often used in garments instead.^{10,11}

The meticulous application of established radiation protection techniques is essential to minimize exposure. Personal protective garments, eyeglasses, and head protection are necessary accoutrements. Collimation of the beam to the specific area being treated is another effective measure; the larger the amount of tissue the beam is penetrating, the greater the amount of scatter radiation. Selecting judicious table height and angulation to minimize scatter is sensible practice, while using high kVp and low mAs techniques reduces scatter and also improves image quality. Mobile lead shields of at least 0.25 mm lead equivalency are recommended for anyone working near the table during fluoroscopy procedures when possible.

The future interventional laboratory must be designed so that radiation safety is not predicated on the voluntary cooperation, sensitivity, and education of operators, but rather is constructed into the design of the laboratory.^{7,12} We may need an automated mechanism to place the shields correctly, or a surrounding shell around the patient. More expansive and encompassing lead shielding systems are commercially available.¹³

It is important that attitudes about personal protection begin to change. Radiation safety needs to be a required labor practice rather than a matter of courtesy.⁷ It is not an uncommon physician opinion that the last thing we need are more rules and regulations. Interventional radiologists and cardiologists are often the first to welcome new technologies. In addition to adopting technologies useful for patient treatment, we must accept the challenge to adopt healthier attitudes and new technologies for the reduction of occupational hazards.⁷⁻⁹ We are teachable if given positive feedback in a manner that reminds us in real time what adequate protection entails.⁶

From the University of California, San Francisco, Cardiology Section, San Francisco, California.

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Address for correspondence: Lloyd W. Klein, MD, University of California, San Francisco, Cardiology Section, 505 Parnassus Ave, M1177A, San Francisco, CA 94143. Email: lloydklein@comcast.net

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