CT Fluoroscopy Shielding: Decreases in Scattered Radiation for the Patient and Operator

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PURPOSE: High-radiation exposure occurs during computed tomographic (CT) fluoroscopy. Patient and operator doses during thoracic and abdominal interventional procedures were studied in the present experiment, and a novel shielding device to reduce exposure to the patient and operator was evaluated.

MATERIALS AND METHODS: With a 16-slice CT scanner in CT fluoroscopy mode (120 kVp, 30 mA), surface dosimetry was performed on adult and pediatric phantoms. The shielding was composed of tungsten antimony in the form of a lightweight polymer sheet. Doses to the patient were measured with and without shielding for thoracic and abdominal procedures. Doses to the operator were recorded with and without phantom, gantry, and table shielding in place. Double-layer lead-free gloves were used by the operator during the procedures.

RESULTS: Tungsten antimony shielding adjacent to the scan plane resulted in a maximum dose reduction of 92.3% to the patient. Maximum 85.6%, 93.3%, and 85.1% dose reductions were observed for the operator's torso, gonads, and hands, respectively. The use of double-layer lead-free gloves resulted in a maximum radiation dose reduction of 97%.

CONCLUSIONS: Methods to reduce exposure during CT fluoroscopy are effective and should be searched for. Significant reduction in radiation doses to the patient and operator can be accomplished with tungsten antimony shielding.

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COMPUTED tomography (CT) has been used to guide interventional procedures of the chest and abdomen for nearly two decades (1,2). CT-guided procedures have continued to increase in number (3) and are less invasive than many surgical options. Despite advances in other areas of imaging, CT has remained the imaging study of choice for many procedures because of its inherently superior contrast and spatial resolution in comparison with conventional fluoroscopy and ultrasonography (US). However, unlike other imaging modalities, conventional CT lacks real-time imaging capabilities. Therefore, CT-guided procedures generally take longer because the region of interest must be intermittently scanned to confirm safe adjustment and placement of the needle or catheter.

CT fluoroscopy is a technique that has been developed in the past decade (4). In this acquisition mode, CT images are reconstructed and displayed nearly in real time. This provides the interventionalist with immediate feedback during the procedure. CT fluoroscopy has been shown to reduce procedure time (5) and increase efficacy compared with standard CT guidance (6).

The inherent drawback of CT fluoroscopy is rather high radiation exposure to the patient and operator, which may explain why CT fluoroscopy has not been more broadly accepted (7). Radiation exposure for the patient is primarily along the scan plane. Because the exposure along the scan plane is cumulative, deterministic effects can be significant (8,9). Scattered radiation from the direct beam and collimator leakage also contribute to the patient dose (10).

For the operator, exposure is primarily a function of scattered radiation and collimator or gantry leakage (7,10). To make intraprocedural needle adjustments during CT fluoroscopy procedures, the operator's hand must be in proximity to the scan plane. Kato et al (11) calculated that, with an annual dose limit of 500 mSv for the hands, a physician with hand exposure would be limited to performing only four CT fluoroscopy procedures a year. Regardless of scan time, exposure can be quite significant (12) because dose rates can exceed 1 mGy/sec with continuous exposure (13).

Because of high radiation doses to patients and personnel, in 1999, the United States Food and Drug Admin-

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