Clinical Evaluation of the ZeroGravity Radiation Protection System for Interventionalists

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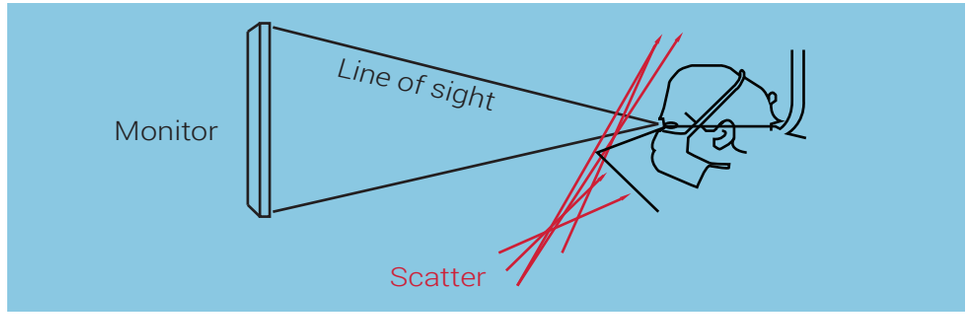
Introduction

A lead apron with thyroid shield and various shielding devices comprise the current standard for radiation protection of the Interventionalist, however leave the operator vulnerable to excessive radiation exposure while inducing debilitating musculoskeletal disorders. Despite suffering significantly increased neck and back pain, time lost from work, and cervical disc herniations ($p<0.01$) (1), exposures remain excessive as shown recently by Wilson, who received the equivalent of 60 skull films during 1 month's practice while using available shielding (2).

The Zerogravity Radiation Protection System (Zgrav) is designed with 3 major goals: Provide considerably greater radiation protection and improve ergonomics and comfort by eliminating weight on the operator, while having a neutral or positive effect on operator task accomplishment. This study reports the initial clinical phase results pertaining to radiation protection, using an early model device.

Methods

A prototype of the overhead-supported ZeroGravity Radiation Protection System (Zgrav) (CFI Medical Solutions, Fenton Michigan) was used during normal clinical activity for 3 interventional radiologists in a university hospital, instead of a standard lead apron, thyroid shield, and lead-acrylic hanging shield. The Zgrav's suspension permits unobstructed, fluid motion in the X, Y, and Z axes, with zero weight placed on the operator. It follows the operator's normal motions due to a readily detachable engagement mechanism that permits all normal activities such as leaning across the procedure table and walking about the area. A sterile plastic drape permits the operator to quickly and repeatedly enter and exit while maintaining sterility, or to leave the area during DSA if desired. This model had a lead apron extending to the distal calves, and flaps hanging over the arms to the elbows (1mm Pb in a central rectangle [63.5 X 69.3 cm], and 0.5 mm Pb peripherally). It also has a curved lead-acrylic head shield (0.5 mm Pb equiv). Photographs show the face shield used for the latter 18 procedures and later studies, which replaced an earlier model of lower height.



Primary operators performed Interventional Radiology cases from transfemoral, transjugular, transhepatic, and other approaches. Six sets of optically stimulated luminescence dosimeters were placed directly on the operator (IN) and corresponding locations outside of the device (OUT), and a badge was placed on operator's rear waist ("back"). Under table skirt shield was usually used, side-table skirt was sometimes used, and hanging lead-acrylic shield was never used. Thirty seven procedures were included, with 379 minutes of fluoroscopy, and a patient dose area product of 331,294 cGycm2.

Discussion

Zgrav provided shielding of body parts that are normally exposed when wearing conventional lead aprons and thyroid shield. IN/OUT ranged from 0-6%. Other shields, such as hanging shields, will provide partial block but leave many gaps and are difficult to position optimally for scatter protection due to interference with the imaging equipment, operating tools, or operator's hands or body. Zgrav maintains constant optimum shielding positioning for all tube angles and operative positions, and covers more body area by shielding the head, proximal arms, and extending well below the knees. The 1 mm Pb equivalent material is greater than conventional aprons, and was shown in previous studies to reduce under-lead exposures by 2/3 relative to standard 0.5 mm Pb (3). Zgrav provided a 16-78 fold decrease in radiation exposure compared to lead apron in a phantom study (4), and a direct comparison in clinical use is currently underway. The ergonomics, comfort, and function were favorable, and will be the subject of more formal studies to follow.

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