INFLUENCE OF CEILING SUSPENDED SCREEN POSITIONING TO THE SCATTER RADIATION LEVELS IN INTERVENTIONAL CARDIOLOGY

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INTRODUCTION

Interventional radiology and cardiology are among the most dynamic areas of medical application of x-rays. These procedures are performed in ever-increasing numbers around the world [1]. Technical improvements of the interventional cardiology and radiology are immense, equipment and workload is growing and procedures are becoming more and more complicated. Often, the new demands result in higher radiation dose, both for patient and staff. Thus, interventional cardiology procedures are classified as high-dose procedures, owing to increased risk for radiation skin injuries and stochastic effects. European MED Directive 97/43 requires special consideration and dose evaluation for this kind of procedures [2].

The benefits of interventional cardiology to patients are both extensive and evident, but many of these procedures also have the potential to produce patient radiation doses high enough to cause radiation effects and occupational doses high enough to cause concern. There are evidences that if radiation protection tools are not routinely used, radiation exposure of interventional radiologists and other professionals using fluoroscopy can be high enough to cause eye lens injuries [3,4].

Interventional cardiology professionals working close to the patient must use a ceiling suspended protective screen, positioned appropriately [3-6]. Ceiling-suspended shields, generally constructed of a transparent leaded plastic, dramatically reduce occupational exposure, including operator eye dose, if they are positioned correctly during the procedure [3,4,7].

The objective of this paper is to identify the effects of the ceiling suspended screen position to the scatter radiation levels in the interventional cardiology.
MATERIAL AND METHODS

The scatter radiation in terms of ambient dose equivalent $H^*(10)$ was measured for various positions of protective screen in the positioned of the first operator, nurse and radiographer, at elevations 100 – 190 cm and in four different angulations of the x-ray tube routinely used in clinical practice (PA, cranial, caudal and spider). To simulate real clinical situation the measurements were performed in the presence of 30 cm PMMA phantom using standard clinical protocol. To assess the effectiveness of the protective screen, the scattered dose was also measured in the absence of any protection in all four angulations and elevations, for the correct positioning of the screen and two additional incorrect positions in which screen was rotated for 90° and elevated from the phantom surface for 20 cm, as presented in Figure 1. The x-ray source to image receptor distance was 105 cm and nominal field of view was 25 cm.

$Figure 1$. Ceiling suspended screen (upper body shield) investigated in this study

The x-ray beam was produced by a clinical interventional radiology system (Siemens Axiom Artis, Siemens Medical Systems, Erlangen, Germany). Scattered dose levels in terms of $H^*(10)$ was measured using a calibrated ionizing chamber 451P (Fluke Biomedical, USA). To assess the effectiveness of the particular position of the screen, a ratio of measured
scatter radiation level with screen to the scattered radiation level without screen was calculated. This parameter was named as dose reduction factor.

RESULTS AND DISCUSSION

The utility of protective screen varied for different positions and angulations. Scatter radiation levels varied from 70 to 3400 µSv/h for the first operator, from 140 to 3200 µSv/h for the nurse and from 50 to 560 µSv/h for radiographer.

Figure 2. Protection from scatter radiation for four different beam orientations and different positions of the ceiling suspended screen for the position of the first operator.

Scatter protection in terms of dose reduction factor provided by three different positions of the screen for various beam orientations for positions of the first operator, second operator/nurse and radiographer are presented in Figures 2-4. Ceiling suspended screens can provide a substantial level of protection (up to factor 18) in interventional cardiology, but they have to be properly managed and positioned to achieve sufficient level of protection. Although the effective use of screen is mainly related to the position of the first operator, the use of this collective protection tool also has an impact on the dose levels to the nursing personnel and radiographers.
Figure 3. Protection from scatter radiation for four different beam orientations and different positions of the ceiling suspended screen for the position of the second operator or nurse.

Figure 4. Protection from scatter radiation for four different beam orientations and different positions of the ceiling suspended screen for the position of the radiographer.
The effectiveness of the shielding for nurse or radiographer staff categories is difficult to estimate due to large variability in the location of this staff categories in the catheterization laboratory and due to the multiple tasks they perform. The screens are primarily positioned to protect the first operator exposed to the highest dose rates, and thus, protection level for other staff categories is smaller. The position of the operator with respect to the x-ray beam and the x-ray beam geometry explains the wide variations of reduction factors. To achieve the maximal protection, it must be positioned to follow the patient cut-off contour and close to the operator to minimize the gap that is created by the patient contour cut-out. Furthermore, the screen should be continuously repositioned, in particular when patient’s table height and beam orientation is altered.

CONCLUSION

Ceiling suspended screens can provide a substantial level of protection in interventional cardiology, but they have to be properly managed and positioned to achieve sufficient level of protection.

REFERENCES

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