Removal of Comfort Pads underneath Babies:

A Method of Reducing Radiation Exposure to Neonates

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Rationale and Objectives: The recent increasing utilization of imaging has increased the population exposure to ionizing radiation. With increasing knowledge of the potential harm of radiation exposure, efforts should be made to minimize patient radiation whenever possible, especially in young children. The purpose of this study was to use the exposure index (EI) standard to assess the potential for reducing radiation dose to babies by removing a soft comfort pad, often placed underneath the baby. The pad is located between the baby and the image detector plate. As such it absorbs x-rays that have already passed through the baby but have not yet reached the imaging detector plate.

Materials and Methods: Using a thoracic infant phantom and fixed exposure factors, we measured the percentage of the radiation exiting a neonatal chest phantom that was absorbed/attenuated by the comfort pad, before it hit the detector to create the image. We studied comfort pads of 4 different thicknesses, ranging from 0.5″ to 8″.

Results: Radiation beam attenuation, ranging from 12% to 72.1%, was found with all comfort pads, with increased x-ray beam attenuation occurring with increasing pad thickness.

Conclusions: The study shows that comfort pads cause a high attenuation of the radiation beam, after it exits the chest phantom. As such, removal of the pads prior to radiographic exposure of babies is a method of potentially reducing patient radiation exposure in the newborn nursery.

Key Words: Radiation safety; radiation dose.

Campaigns such as the "Image Gently Campaign" have led to increasing recent discussion of radiation safety, with special considerations given to pediatric patients (1–4). As children live longer than adults, it is thought that they have an increased risk of developing long-term complications from radiation, such as cancer (1). The newborn intensive care nursery is a most important location for radiation exposure monitoring as it contains our youngest patients, many of whom may require serial imaging at high frequency.

After passing through the patient the x-ray beam hits an image detector plate, which converts the energy in the x-ray beam into a digital image. Measuring the radiation dose at the detector plate is an indirect method of measuring the radiation that has been used. Older methods of determining the radiation dose at the image detector plate varied by manufacturer of the image equipment (5–7). To avoid the confusion of this variability, a new universal standard has been agreed upon and the new term for describing the radiation dose, measured at the level of the detector plate, is called the exposure index (7,8). This exposure index essentially provides the ability to monitor patient's radiation exposure. The exposure index increases in a linear manner as the mAs is increased. Doubling the mAs will double the exposure index (6,8). The response to change in kVp is not linear.

The Z-Flow Neonatal Fluidized Comfort Pads (Sundance Enterprises Inc, White Plains, New York) have become a frequent tool used to improve therapeutic positioning and comfort of babies in the neonatal intensive care nursery. According to the manufacturer, the goal of such comfort pads is to provide a soft material for the baby to lie on and to "comfort, support and help premature and ill infants continue normal development with containment in an individually molded nest" (9). When portable radiographic studies are performed, any beam attenuated/absorbed by the pad occurs after the radiation has already passed through the baby. It is thus unnecessary radiation to the baby, as it does not reach the detector plate that creates the image. Pad removal prior to taking the radiograph may thus be a method of potentially reducing patient radiation.

By calculating the percentage of the x-ray beam attenuated/absorbed by the comfort pad, our objective was to evaluate

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the impact of the presence of the comfort pads on radiation exposure for portable neonatal computed chest radiographs. We planned to simulate the clinical situation by using a neonatal chest phantom and a portable radiography unit.

METHODS

Images of a neonatal chest phantom were performed, with and without a comfort pad placed between the chest phantom and the image detector plate. The phantom used in this study (Gammex Neonatal Chest Phantom, Gammex Corp, Middleton, WI) simulates the thorax of a 1500-g baby (Fig 1). Portable radiographs were obtained using a GE AMX 4 portable x-ray unit (GE Healthcare, Milwaukee, WI) having a 3.4-mm aluminum filter. Anode-plate distance was 40 inches and kept constant for all radiographs. Exposure factors were kept constant. Collimator positions were kept constant. The only variable was the presence or absence of the comfort pad.

We evaluated the attenuation produced by four comfort pads of different thicknesses. These were 0.5 inch, 1.0 inches, 3.0 inches, and 8 inches. We used the exposure factors that we would normally use for a 1500-g baby in our newborn intensive care nursery. These are kVp of 66 and mAs of 1.0. To further evaluate the effects of changes in kVp, the study was repeated using kVps of 56 and 76, also with mAs of 1.0. The comfort pads are soft. Prior to imaging, the pads were smoothed by hand to make the pad surface as flat as possible.

The images were processed on Agfa Healthcare's DXS CR system (Ridgefield Park, NJ) and the NX technologist workstation and exposure-monitoring quality-assurance software. The exposure index was recorded for each exposure. The software provides storage of the exposure index for every image.

After retrieval and documentation of the exposure index, a percent reduction of the x-ray beam by the comfort pad was performed using the following equation:

$$\text{Percent exposure index reduction} = \frac{\text{exposure index without pad} - \text{exposure index with pad}}{\text{exposure index without pad}}$$

The percent exposure index reduction serves as a measure of beam attenuation and absorption secondary to the presence of the comfort pad. To evaluate for significant difference between the exposure index with and without the pad at each kVp, statistical analysis was performed using paired, one-tailed, *t* testing for type 1 data of repeated measurements. Standard deviation calculations were performed for the percent reduction at each thickness with varying kVp.

RESULTS

The x-ray beam was attenuated by all of the comfort pads, demonstrated by the consistently lower exposure index at all pad thicknesses. The beam attenuation produced by pads of varying thickness, with kVp of 66, ranged from 12% to 72.1% (Table 1). Attenuation increased with increasing pad thickness. Changes in kVp resulted in differing percent reduction in exposure index for each pad thickness (Fig 2, Tables 1 and 2). As might be expected, the exposure index increased as the kVp was increased.

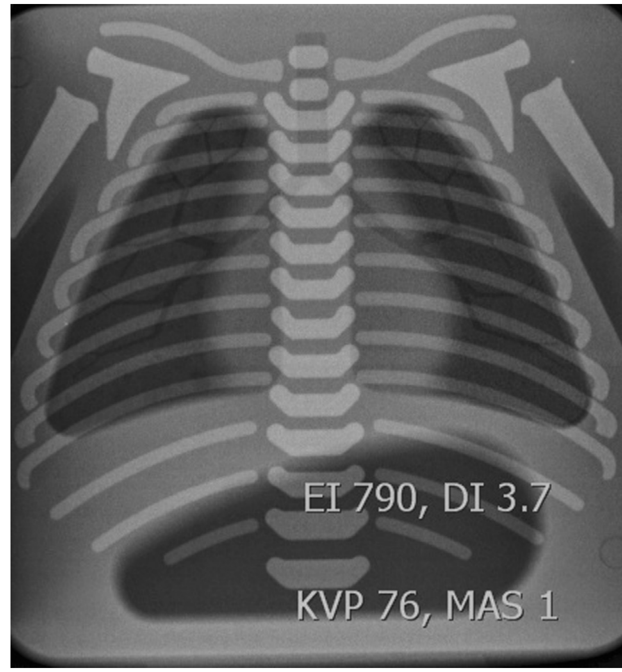

Figure 1. Representative phantom radiograph.

DISCUSSION

Our study has demonstrated that comfort pads absorb radiation after it has exited the patient. Removal of pads prior to imaging provides yet another method of reducing radiation dose to babies.

The responsible administration of ionizing radiation for diagnostic purposes has become a central issue in radiology and health care, with the principles of imaging gently and using radiation “As Low As Reasonably Achievable” (ALARA), providing much needed guidance (1). Reduction of dose is especially important in the pediatric population, as pediatric patients may be more sensitive to ionizing radiation than adults (1). The actual exposure to a baby from a single chest radiograph is small, probably less than 1 week's exposure from natural background radiation. However, small and critically ill babies in the neonatal intensive care unit settings often require serial imaging such that any decrease in exposure for each image becomes important.

We chose not to measure the actual radiation at the detector plate, but only to measure the percent of the radiation absorbed/attenuated by the comfort pad. As the only variable in our experiment was the presence or absence of the comfort