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How Breast Tissue Is Affected During Upper Extremity Exams

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Abstract

An experiment was conducted to see how the breast tissue is affected with and without lead shielding during both a two-view elbow and a two-view hand exposure. The purpose of this study was to see if lead shielding would lessen the amount of radiation dose to the breast tissue during upper extremity x-rays. Radiosensitive tissues, like breast tissue, when exposed to high doses of ionizing radiation have a higher risk of developing into cancer. The results of the study indicate that lead shielding does indeed lessen the amount of radiation to the breast tissue significantly.

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An experiment was conducted to see how the breast tissue is affected with and without lead shielding during both a two-view elbow and a two-view hand exposure. The purpose of this study was to see if lead shielding would lessen the amount of radiation dose to the breast tissue during upper extremity x-rays. Radiosensitive tissues, like breast tissue, when exposed to high doses of ionizing radiation have a higher risk of developing into cancer. The results of the study indicate that lead shielding does indeed lessen the amount of radiation to the breast tissue significantly.

METHODS AND MATERIALS

A consistent room set up along with consistent collimation of 8x10 inches was used throughout the experiment. A dosimeter was placed on the front of a phantom for the first part of the experiment, and then moved to the left side of the phantom for the second part. Data was collected from six rounds of the experiment and averaged into two tables.

- Quantum Imaging X-ray system with Carestream Retrofit
- 14x17 Flat Panel Digital Image Receptor Plate
- Thorax Phantom
- Fluke Triad Biomedical Dosimeter
- 0.5 mm Half Apron Lead Shield
- Silk tape

The room was set up with a thorax phantom on a chair next to the x-ray table with an arm phantom and hand phantom placed on top of a 14x17 inch flat panel digital imaging receptor plate that was placed on the x-ray table. The collimation was set at a consistent 8x10 inches for all images taken. A Fluke Triad Biomedical Dosimeter was used throughout both parts of the experiment. For the first part of the experiment the dosimeter was taped on the front of the thorax phantom in between the breasts, and for the second part the dosimeter was placed on the left side of the phantom on the side underneath the axilla to simulate the side of a breast.

The experiment was conducted six times to ensure reliable results with recorded doses averaged. The first part of the experiment was done with the dosimeter on the front of the thorax phantom and the second part of the experiment was done with the dosimeter placed on the side of the phantom. Images were taken of the hand and of the elbow in both anteroposterior (AP) and lateral positions with and without lead shielding for both parts of the experiment.

RESULTS

Table 1

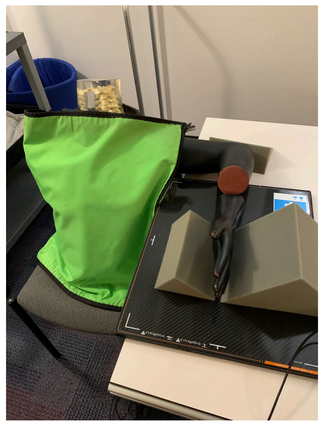
Average Dose to Breast Tissue With and Without Lead Shielding - Dosimeter on front of phantom

Position of Phantom	Technique	Breast Tissue Shielded	Average dose (mR)
Hand PA	55 kVp @ 1.3 mAs	No	0.0816 mR
Hand LAT	55 kVp @ 1.9 mAs	No	0.1446 mR
Elbow AP	60 kVp @ 1.6 mAs	No	0.1492 mR
Elbow LAT	60 kVp @ 2.6 mAs	No	0.3305 mR
Hand PA	55 kVp @ 1.3 mAs	Yes	0 mR
Hand LAT	55 kVp @ 1.9 mAs	Yes	0 mR
Elbow AP	60 kVp @ 1.6 mAs	Yes	0 mR
Elbow LAT	60 kVp @ 2.6 mAs	Yes	0 mR

Table 2

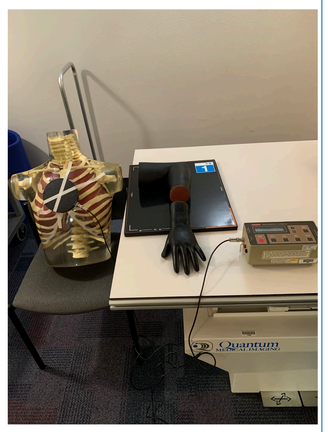
Average Dose to Breast Tissue With and Without Lead Shielding - Dosimeter on side of phantom

Position of Phantom	Technique	Breast Tissue Shielded	Average dose (mR)
Hand PA	55 kVp @ 1.3 mAs	No	0.0644 mR
Hand LAT	55 kVp @ 1.9 mAs	No	0.1497 mR
Elbow AP	60 kVp @ 1.6 mAs	No	0.2281 mR
Elbow LAT	60 kVp @ 2.6 mAs	No	0.3973 mR
Hand PA	55 kVp @ 1.3 mAs	Yes	0 mR
Hand LAT	55 kVp @ 1.9 mAs	Yes	0.0392 mR
Elbow AP	60 kVp @ 1.6 mAs	Yes	0.1688 mR
Elbow LAT	60 kVp @ 2.6 mAs	Yes	0.2894 mR



RECOMMENDATIONS

Because shielding of the breast tissue was never part of the normal shielding routine, research on how breast tissue is affected during upper extremity exams is limited. Most research about how ionizing radiation affects breast tissue is focused on scoliosis exams or mammography because breast tissue is being directly affected. Further research on how breast tissue is affected by scatter radiation when breasts are directly next to the anatomy in question is needed. Having more information on this subject could be beneficial for new technologies that are working to decrease scatter radiation production in x-ray equipment. Other research on the subject could also focus on how breast tissue is being affected during other diagnostic imaging modalities such as fluoroscopy and CT exams where breast tissue is not directly affected, but are exposed to higher doses of radiation.



DATA ANALYSIS

Based on the data collected during the experiments that were completed in the radiology laboratory, lead shielding either reduces the dose to breast tissue by 100 percent, or it reduces it by 25 to 74 percent. For the first portion of the experiment in which the dosimeter was placed on the front of the thorax phantom between the breasts, when the lead shield was placed over the phantom the doses were reduced by 100 percent as seen in Table 1. During the second part of the experiment with the dosimeter on the side of the phantom, the lead shielding did not completely reduce the dose to zero, but it did reduce the doses overall. As seen in Table 2, when x-rays were taken of the hand phantom with and without lead shielding, the doses were reduced by 100 percent and then 74 percent. For the elbow x-rays, the doses were reduced by 25 percent and 27 percent. What can be seen through these results is that as you go farther down the arm, the dose to the breast tissue is overall lower than if you were to go farther up the arm, both with and without the lead shielding. Lead shielding significantly reduced the dose to breast tissue during upper extremity exams.

CONCLUSION

The null hypothesis that lead shielding does not lessen the dose to the breast tissue during upper extremity x-rays can be rejected. Table 1 shows that when the dosimeter was placed on the front of the Thorax phantom, the dosimeter did not pick up any scatter radiation when the shielding was used for both the hand and elbow projections. But when looking at Table 2, you can see that the dosimeter did pick up scatter radiation when the dosimeter was placed on the side of phantom. When the hand was being projected, the dosimeter only picked up scatter radiation when the hand was in the lateral position. But when the elbow was being projected, the dosimeter was able to pick up scatter radiation for both the PA and lateral projections. Because breast tissue extends into the axilla, there is a small amount of scatter radiation being absorbed even when shielding was used. Even though the breast tissue was still exposed to scatter radiation, we can see from the results of this experiment that using the lead shielding did decrease the amount of scatter radiation the breast is exposed to.

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