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Thyroid Shielding in Radiographic Procedures: Fit vs Dose

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Abstract

The thyroid gland is a vital hormone gland that plays a major role in the metabolism, growth and development of the human body. The thyroid gland is among the most radiosensitive organs. The usage of thyroid shields by healthcare professionals is an essential precaution for radiation protection. The purpose of this experiment was to determine if thyroid shield fit affects radiation dose received to the thyroid gland. The fit was recorded by measuring from the jugular notch or location of thyroid, to the inside of the thyroid shield. Qualitative data was collected by interviewing staff technologists on whether or not they thought thyroid shield fit was important.

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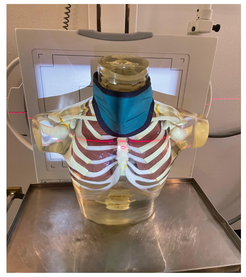


Methodology

For the experiments conducted, an ionization chamber was placed between the jugular notch of a thorax phantom and the thyroid shield. Phantoms are specially designed objects used in medical imaging that mimic human anatomy. Ionization chambers are used to measure radiation output from radiographic equipment. The thorax phantom was placed in anterior to posterior (AP) position against the wall bucky. The central ray of the x-ray tube was directed to the jugular notch and at the center of the cassette. A thyroid shield was placed at the seventh cervical vertebrae to identify the thyroid gland. The distance of the shield to the thyroid gland was deliberately varied to demonstrate the inconsistency of a radiologic technologist's thyroid shield fit. Data was collected using a 40 in. and 72 in. source to image distance (SID) and exposure factors of 110 kilovoltage peak (kVp) @ 10 milliampere-seconds (mAs). The dosimeter was placed at the level of the thyroid cartilage ranging from 1 cm - 2 in. gaps to determine the dose received at each level. A survey was conducted by interviewing various radiologic technologists from several hospitals in the pacific northwest about thyroid shield placement. Technologists were asked various questions about personal experience with thyroid shielding.

Data Collected:

Table 1: Dosimeter Readings @ 40” SID

Distance	Dosimeter Readings	Percent Increase
Thyroid shield 1 cm gap	0.872 mR	Baseline
Thyroid shield 1 in. gap	0.950 mR	8.94%
Thyroid shield 1.5 in. gap	0.981 mR	3.27%
Thyroid shield 2 in. gap	1.452 mR	48.01%

Table 2: Dosimeter Readings @ 72” SID

Distance	Dosimeter Reading	Percent Increase
Thyroid shield 1 cm gap	.239 mR	Baseline
Thyroid shield 1 in. gap	.252 mR	5.44%
Thyroid shield 1.5 in. gap	.283 mR	12.30%
Thyroid shield 2 in. gap	.684 mR	141.69%

Data Analysis:

Table 1:

When comparing a thyroid shield gap of 1cm to a 1 in. gap there was only a 0.076mR increase in dose. There was little difference between 1in. gap and 1.5 in. gap with a dose increase of 0.031mR. However, when the gap was increased to 2 in. there was a 0.580 mR increase in dose from a 1 cm gap. This data demonstrates that dose will begin to significantly increase when the thyroid shield gap is 2 in. or greater.

Table 2:

Series was conducted using a 72 in. SID. When comparing a 1cm gap to a 1in. Gap, there was a 0.039mR increase in dose. When changing from a 1in. gap to a 1.5 in. gap, there was a 0.031 mR increase in dose. The largest dose increase of 0.445mR was seen when comparing the 1 cm gap to the 2 in. gap. A notable increase in dose of 0.401mR was seen between the 1.5 in. gap and the 2 in. gap.

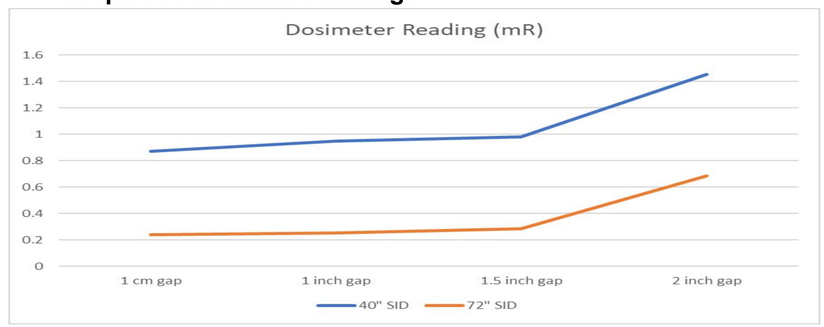
Figure 1:

This line graph includes the data collected from a 40 in. SID and also from a 72 in. SID. It is seen that when the thyroid shield has a 1.5 in. gap or greater, the radiation dose received in this area of the body is noticeably higher. A gap of 1.5 in. or smaller resulted in negligible difference in dose. The results were the same for both 40 in. SID and 72 in. SID.

Qualitative Analysis Results:

Of the 21 technologists interviewed, 66% of the respondents actively worried about the proper fit of a thyroid shield, the other 34% were either unsure or not concerned about the fit.

Graph of Dosimeter Readings



Recommendations

Limitations were possible, inaccuracy of the dosimeter and the fit of the thyroid shield not being an exact science. Normally, you would not direct the x-ray tube directly at the person wearing the lead, but for the purposes of this experiment we needed the dosimeter to pick up enough dose to be measurable. This may make our dose measurements higher than they would be in a real world setting.

Further experiments that could have been performed are simulating surgery with a C-arm and recording the dose the radiologic technologist would get with different fits of the thyroid shield. Also, we could have simulated a parent holding at child scenario and the dose the parent receives with different fits of the thyroid shield.

Our recommendation is that more education be given to radiologic technologists to always wear their thyroid shield comfortably snug at a distance from the neck of 1.5 inches or less. To keep technologists from receiving more dose than needed they practice as low as reasonably achievable (ALARA), minimize time exposed, maximize distance from radiation, and use lead shielding. Some suggestions to better protect technologists is to wear leaded glasses, have bigger rooms to allow for more distance, and stand behind the C-arm instead of directly next to it to minimize scatter radiation.

Conclusions

Overall, our research and experiment has suggested that donning a thyroid shield and wearing it comfortably snug, or with a 1.5 in. gap or less between the neck and thyroid shield, is a good way of protecting medical radiation workers from excessive amounts of thyroid radiation exposure. This is of particular importance because the thyroid is a very radiosensitive organ, which means it’s very susceptible to cancer.

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