THE EFFECT OF RADIATION PROTECTION ON THE DEVELOPMENT OF THYROID NODULES AMONG RADIOGRAPHERS IN MALANG

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Abstract

The use of radiation technology in Indonesia is mostly applied in the medical world and is immensely beneficial, but radiation exposure also has negative effects on health in the form of deterministic and stochastic effects. The thyroid gland is at a high risk of radiation exposure, which leads to the development of thyroid nodules. To prevent that, there must be safety measures in the use of radiation technology by implementing radiation protection, such as a thyroid shield. This study aims to examine the effect of the compliant use of a thyroid shield on the development of thyroid nodules among radiographers in Malang. This study is an observational study with the use of secondary data, where the primary data were previously gathered cross-sectionally in April 2021. The data from 40 subjects were then analyzed using a T-test with the result of the t-value = 4.299 and α = 0.000. With the result of α < 0.05 and t-value > t-distribution, this study concludes that the use of a thyroid shield has an effect on the development of thyroid nodules among radiographers in Malang, and compliant use can lower the incidence of thyroid nodules.

Keywords: Radiation exposure, radiographer, thyroid nodule, thyroid

INTRODUCTION

The use of radiation technology in Indonesia is mostly applied in the medical world and is immensely beneficial, with its use categorized into diagnostic radiology or interventional radiology1. However, aside from the benefits, radiation exposure also poses negative effects on health in the form of deterministic and stochastic effects. Deterministic effects or harmful tissue reactions are damage to tissues after being exposed to radiation beyond the threshold level and increasing in severity as the radiation dose increases, whilst stochastic effects are the effects of radiation that occur after prolonged exposure and increase in probability as the radiation dose increased2. Stochastic effects are causing permanent damage to cells and can manifest into the induction of cancer or a DNA mutation that can cause the disease to be heritable2.

To prevent such effects in radiographers and other radiation workers, radiation protection is used in every use of radiation technology3,4. Radiation protection is implemented according to the principles of radiation protection by minimizing exposure time, maximizing distance from the exposure source, and using radiation shielding5. Of the three methods, the most effective one is the use of proper radiation shielding6.

The thyroid gland is one of the organs at the highest risk of radiation exposure2 and is essential to the production of hormones for metabolism and homeostasis7. It also produces reactive oxygen species (ROS) that will cause oxidative stress—the damaging effect of which will increase with the presence of radiation exposure8—and, thus, prolonged exposure to radiation can lead to the development of thyroid nodules. The radiation shielding that is used to minimize this exposure is thyroid shield9.

The incidence of thyroid nodules caused by prolonged radiation exposure in radiographers is high. According to a study in Khartoum, Sudan, by Elzaki et al., thyroid nodules are found in 38 of 103 radiographers.
participating in the study (36.9%), in which inadequate use of radiation shielding is one of the risk factors for the development of thyroid nodule\textsuperscript{10}. In Indonesia, there is no data available yet regarding this matter, but Riset Kesehatan Dasar (Basic Medical Research) done by the Ministry of Health in 2013 showed that the incidence of hyperthyroidism is 0.4\%\textsuperscript{11}, and one of the causes of hyperthyroidism is the presence of thyroid nodules. Thus, this study aimed to examine the effect of compliant use of thyroid shield on the development of thyroid nodules among radiographers in Malang.

METHODS

This is an observational study analyzing secondary data, in which the primary data were previously gathered in April 2021 at the Radiology Department of Saiful Anwar Hospital, Malang, Indonesia, on 40 radiographers with the inclusion criteria of working for a minimum of 5 years. Radiographers who have a history of thyroidectomy and/or radiation therapy were excluded from the study. Data for compliance with thyroid shield use were gathered through history-taking, followed by physical examination and USG examination to confirm the presence of thyroid nodules. The data then were analyzed with linear regression and T-test with a 95\% confidence interval.

RESULTS

From a total of 40 radiographers, thyroid nodules were found via physical examination and/or USG examination in 15 people (37.5\%). History-taking of radiographers’ compliance with using a thyroid shield showed that 9 people never used a thyroid shield while working (22.5\%), 10 people used a thyroid shield 1–5 times while working for every 10 patients (25\%), 12 people used a thyroid shield 6–9 times while working for every 10 patients (30\%), and 9 people always use a thyroid shield while working (22.5\%). The data are shown in Table 1.

<table>
<thead>
<tr>
<th>Presence of thyroid nodules</th>
<th>Radiographers (n = 40 [n (%)])</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td>37.5</td>
</tr>
<tr>
<td>Not present</td>
<td>62.5</td>
</tr>
</tbody>
</table>

Radiographers’ compliance with using thyroid shield

<table>
<thead>
<tr>
<th>Uses a thyroid shield 1–5 times while working for every 10 patients</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uses a thyroid shield 6–9 times while working for every 10 patients</td>
<td>30</td>
</tr>
<tr>
<td>Always uses thyroid shield while working</td>
<td>22.5</td>
</tr>
</tbody>
</table>

The data were then analyzed with linear regression. From the result, compliant use of thyroid shield has a 32.7\% effect on the development of thyroid nodules among radiographers. Meanwhile, the remaining 67.3\% are influenced by other factors.

<table>
<thead>
<tr>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. E</th>
</tr>
</thead>
<tbody>
<tr>
<td>.572</td>
<td>.327</td>
<td>.309</td>
<td>.407</td>
</tr>
</tbody>
</table>

Then, the data were analyzed with T-test with a 95\% confidence interval. From the test, a t-value of 4.299 with a significance level of 0.000 was obtained, which concludes that compliant use of a thyroid shield has a 32.7\% effect on the prevention of the development of thyroid nodules among radiographers in Malang, in which compliant
use can lower the incidence of thyroid nodules.

Table 3. The Result of the T-test

<table>
<thead>
<tr>
<th>Unstandardized B</th>
<th>Coefficients Std. Error</th>
<th>Standardized Coefficients Beta</th>
<th>t</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliance with thyroid shield use</td>
<td>.258</td>
<td>.060</td>
<td>.527</td>
<td>.42</td>
</tr>
</tbody>
</table>

DISCUSSION

A thyroid shield works as an attenuator of radiation emitted by radioactive equipment, usually made of lead (Pb) or other materials that have the same attenuating properties. This acts as a means of protection that would reduce the dose of exposure. As a result, it will inhibit any permanent cell damage and prevent the development of any adverse effects, such as thyroid nodules. However, compliant use of a thyroid shield is not the only factor in play. Other factors include the other principles of radiation protection, such as the time of exposure, the distance between the radiographers and the radioactive equipment, internal radiation exposure, and inherent risk factors that the radiographers have.

Maximizing the distance from the source of radiation exposure is another protection against external radiation—the total exposure dose sustained by radiographers is inversely proportional to the squared distance from the source of exposure. As technological advancement grows, equipment used in radiology are varying in type with a different minimum distance of operation from one piece of equipment to another. Some radiological instruments, mammography, and fluoroscopy, for example, are needed to be operated at a close range. Aside from that, health workers and radiographers sometimes need to be with the patient near the equipment to watch over their conditions, serving as another obstacle in maintaining distance.

Radiation exposure can also be caused by contamination. When a radioactive substance enters the body, there will be a continued decaying process until the substance is no longer radioactive or excreted from the body, and these processes are directly influenced by the chemical properties of the substance. Some radioactive substances, like radioactive iodine, will be concentrated in the thyroid gland with regard to the gland’s physiological activity to take up iodine for hormone production.

Inherent risk factors of the radiographers are also a key factor in the development of thyroid nodules. Some factors that can increase the risk of multinodular goiter include genetic predisposition, iodine and selenium deficiency, lithium therapy, and

Figure 1. A Thyroid Shield used by a Radiographer

Minimizing the time of exposure is also one of the protections against external radiation—the total exposure dose is directly proportional to the rate of exposure and time of exposure. Thus, if the time of exposure is prolonged, then, the total dose sustained by the radiographers will be higher despite the slow rate of exposure. In this study, the radiographers have been working for over 5 years, which the previous studies concluded as the minimum latent period of radiation exposure before thyroid cancer appears.
smoking. Other factors that can increase the risk of thyroid cancer are genetic predisposition, a history of thyroid disease (structural or functional), iodine deficiency, sex (women being more susceptible than men), tall stature with a great BMI, and smoking habit.\[15\]

**CONCLUSION**

The use of a thyroid shield has an effect on the development of thyroid nodules among radiographers in Malang, in which compliant use can lower the incidence of thyroid nodules. Further studies with larger samples are needed to examine the effect of time, distance, and the internal risk factors of radiographers in the development of thyroid nodules.

**ACKNOWLEDGEMENTS**

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