ANALYSIS OF EYE LENS EFFECTIVE DOSE OF WORKERS DURING CARDIAC CATHERIZATION EXAMINATION IN A CATHLAB ROOM

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Abstract *C-Arm equipment is commonly used for three-dimensional patient imaging in real time using fluoroscopy techniques. This study aims to evaluate the effective dose of eye lens received by radiation workers during cardiac catheterization. The main tool uses the C-Arm equipment and the calibrated TLD detector chip. The object of observation is the eye lens of radiation workers consisting of one radiologist and one nurse. Catheterization was carried out to 10 patients with different examination times. As the observation results, for the eye lens without protective glasses; the average effective doses received by medical doctors and the nurse for a single imaging are, respectively in the ranges of 0.0011 and 0.0054 mSv, and in the ranges of 0.0010 mSv and 0.0025 mSv, or about 0.0037 mSv/h - 0.0135 mSv/h for the medical doctors and about 0.0027- 0.00830 mSv/h for the nurse. Estimated dose received by medical doctors and nurse are, respectively, in the range of 0.0037 - 0.0135 mSv/h and 0.0027-0.0083 mSv/h*

INTRODUCTION

Cardiac catheterization is carried out in a special room, namely in the cardiac catheterization laboratory, or better known as the Cath Lab. The main equipment used in the cardiac catheterization room is X-ray fluoroscopy (1). This tool serves as a guide for the doctor so that the catheter can be placed in the right position. This tool can show the process of carrying out medical procedures such as bone surgery or parts of other human organs in real time.

C-Arm fluoroscopy technology works by passing X-ray beams through the patient's body. This technology has the ability to display three-dimensional object images from various sides and positions continuously. Objects can be seen more clearly and intact, thereby minimizing errors in predicting object location, diagnosing and other medical procedures. C-Arm is also an accurate method of performing radiography of blood vessels (coronary angiography).

The use of X-rays in imaging equipment technology has great benefits in the health field. However, on the other hand, there is a risk if the dose of radiation exposure used exceeds the permissible safe limit. Among them are that it can cause cancer later in life, effects on cataract tissue, skin redness, and hair loss, possibly reactions associated with intravenously injected contrast agents. Therefore, the radiation dose used and received by radiation workers must still be controlled or limited (2,3).

The Nuclear Energy Monitoring Agency (BAPETEN) has issued regulation Number 5 of 2016 concerning radiation safety in the production of consumer goods (4), Article 23 states: for radiation workers, the dose received by the lens of the eye may not exceed 20 mSv per year on average for 5 (five) consecutive years, and 50 mSv in 1 (one) year. As is known, the effects of radiation caused by the eye organs can cause damage to the eye organs such as causing cataracts and damage to other eye organs (5).

The problem that is often found in the field is that many radiation workers do not comply with and ignore the principles and procedures of radiation protection when operating fluoroscopy equipment. Therefore, it is necessary to conduct a study to evaluate the radiation dose received by radiation workers who work in the Cath-Lab room when performing interventional radiology and cardiac vascular catheterization both for therapy and diagnosis, especially for the vital organs of the eye which are very sensitive to X-ray radiation (6).

EXPERIMENTAL SECTION

Materials

This study used a quantitative method, in which in this study measurements of absorbed dose reception were carried out in the area around the eyes during pacemaker examinations for medical doctors and nurses working in radiation areas, measured using a Thermo Luminesence Dosimeter (TLD).

Instrumentation

The initial step is to prepare the C-Arm aircraft, then attach the TLD in the area around the eye organs of the medical doctors and nurses who work before the coronary angiography examination is carried out. After the examination is complete, the TLD is removed and read in the Dosimeters Laboratory, after being left for 12 hours or more.

Methods

1. Implementation Procedure

To find out the dose value recorded on the TLD, it is read using the Harshaw Model 3500 TLD Reader. The TLD is entered into the TLD reader, then the reading results are displayed graphically on the computer screen. The reading process requires a maximum temperature of 220^0C for TLD-100H and 260^0C for TLD 100 and a minimum temperature of 50^0C.

Before TLD-100H and TLD-100 are used for research, an annealing process is carried out with the aim that the doses previously recorded in TLD-100H and TLD-100 are erased to close to 0.

2. Annealing process on TLD-100H

The TLD-100H annealing process is carried out in an oven. The TLD is arranged in an aluminium container and then put into the oven by heating the oven from room temperature to 200^oC. After the temperature reaches 200^oC, it is left for 10 minutes and then the oven is turned off, so that the TLD can be cooled down to room temperature by opening the oven door.

3. Annealing process TLD-100

The TLD-100 annealing process is carried out in a furnace. TLD is arranged in an aluminium plate container and then put into the furnace with an initial heating temperature from room temperature (28^oC) to 400oC with a time needed of approximately 15 minutes.

Then let it stand after the temperature reaches 400^oC within 1 hour. After the TLD is heated, in the next process the temperature of the furnace will automatically drop from 400^oC to 100^oC in approximately 2 hours, then the furnace is opened so that the cooling process is faster.

After cooling, the next annealing process is carried out in the oven. The method is almost the same as TLD-100H. The difference is the long pause of heating in the oven before cooling down. If in TLD-100H after reaching a temperature of 200^oC a 10 minutes break is given before the oven is turned off and cooled down, but for TLD-100 it takes 1 hour of heating time and the rest of the process is the same.

RESULTS AND DISCUSSION

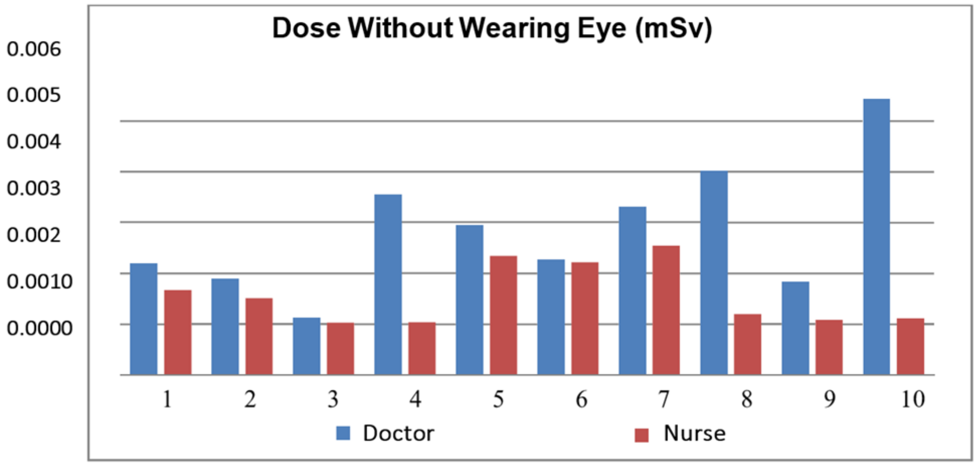
The research was carried out starting from the insertion of the catheter into the artery with the help of directions from the use of X-rays. Acceptance of the dose to be studied uses two different types of TLD (Thermoluminisence Dosimeter), namely 10 packages of TLD-100 and 10 packages of TLD-100H and plus one package of TLD-100 and one package of TLD-100H to be used as background. In this study, 10 samples were taken for Percutaneous Coronary Intervention (PCI) examination.

This research was carried out by attaching TLD-100 to each TLD-100H around the eyes of doctors and nurses when examining patients with Percutaneous Coronary Intervention (PCI) cases. Measurements were made to determine the dose to the eye organs without the use of goggles. The exposure factor setting used in this study is an automatic exposure factor with different kV and mAs values for the thickness of the object to be seen in the arterial selection process with the insertion of a catheter accompanied by contrast. Then after the Percutaneous Coronary Intervention (PCI) examination is carried out, the TLD that has been used will be read using a TLD reader in the Dosimetry Laboratory. After conducting the research and calculating the dose value obtained from the TLD, the equivalent dose and effective dose were calculated. The results of receiving doses to the eyes if not using protective glasses are presented in Table 4.1

Figure 4.1. presents a diagram of the effective dose received by the eye organ of a sample of medical doctors and nurses without the use of eye protection in the Percutaneous Coronary Intervention (PCI) examination. In the figure it can be seen that almost all of the charts are light blue, especially numbers 4, 5, 7, 8 and 10. looks higher than on the chart in dark red. This shows that the effective dose received by the medical doctor's sample is higher than that of the nurse's sample, without using radiation protection glasses (7).

Table 4.1 Radiation doses for doctors and nurses without wearing goggles.

No. Action Sort	Examination Time (minutes)	Effective dose (mSv/h)	
		Medical Doctor	Nurse
1	25	0,0053	0,0038
2	32	0,0054	0,0034
3	18	0,0037	0,0033
4	27	0,0080	0,0027
5	20	0,0093	0,0069
6	16	0,0086	0,0083
7	36	0,0055	0,0042
8	21	0,0117	0,0034
9	15	0,0072	0,0044
10	24	0,0135	0,0040



Picture 4.1 Dose Effective Without Wearing Eye.

Dosage Received Eye Organ

This radiation dose was measured when the Percutaneous Coronary Intervention was carried out using the Philips Azurion C-Arm device at the Cath Lab Installation, Harapan Kita Hospital, Jakarta. Based on the calculation results, it can be seen that the value of the effective dose exposed to the eye organs of medical doctors and nurses varies according to the length of the examination. The length of time of action is not the same for every patient, and really depends on the patient's condition. In this study the number of samples of patients involved was 10 people (8,9).

The effective dose received by the medical doctor's eye organ without using protective glasses ranges from 0.0011 – 0.0054 mSv, and 0.0010 – 0.0025 mSv for nurses (10). Meanwhile, the effective dose received by the medical doctor's eye organ when using protective glasses ranges from 0.00005 – 0.00022 mSv and 0.00001 – 0.00010 mSv for nurses. This value is still categorized within safe limits and is still far below the tolerance limit set by PERKA BAPETEN No. 8 of 2011, which is 20 mSv.

According to the International Commission of Radiological Protection (ICRP) 103, the eye threshold value for cataract risk is 0.5 Sv or 500 mSv per year (11). If the average value of the effective dose received by the eye organs without using goggles is multiplied within 1 year, namely with the range 1.168 - 8.4315 mSv/hour for medical doctors and with a range of 0.803 - 1.7155 mSv/hour for nurses, the results will be different if using self-radiation protection by wearing protective glasses (12). If the effective dose received by the eye organ is multiplied over a period of 1 year, the resulting dose is between 0.0365 - 0.3285 mSv/hour for doctors and 0.0109 - 0.1460 mSv/hour for nurses (13).

CONCLUSION

From the results of the measurement and analysis it was concluded that the accumulated effective dose received by the eye organs without wearing radiation protection glasses during the Percutaneous Coronary Intervention examination varies in the range of 0.0011-0.0054 mSv for medical doctors and the range of 0.0010 - 0.0025 mSv for nurses. Estimated dose received by medical doctor and nurse are, respectively, in the range of 0.0037 - 0.0135 mSv/h and 0.0027 - 0.0083 mSv/h.

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