

Measurement of Radiation Dose Received by the Eye Lens in Panoramic Examination Using a Thermoluminescence Dosimeter (TLD) in the Radiology Installation of Andalas University Hospital

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Abstract

A panoramic examination is an examination used to show the upper and lower jaws along with abnormalities in the oral area. The lens of the eye is a sensitive organ that is exposed to radiation during a panoramic examination. The lens of the eye that is exposed to radiation for a long time can cause cataracts that can develop to blindness, therefore to prevent cataracts, BAPETEN No. 6 of 2010 sets a deterministic threshold limit for the chance of cataracts at 15 mSv per year. This study aims to determine how much dose the lens of the eye receives during a panoramic examination and whether the dose received exceeds the established NBD. This type of research is an experimental quantitative study conducted at the Radiology Installation of Andalas University Hospital in September 2025 using a sample of 7 patients. The instruments and materials used are a panoramic machine, TLD and plaster isolation. Dose measurement is done by attaching the TLD to the patient's right and left eyelids then exposed using 73 kV, 10 mA and 10.8 s and then the TLD reading process is carried out. The measurement results obtained in nC units with the final result in the form of an effective dose compared with BAPETEN regulation No. 6 of 2010. The highest effective dose measurement result received by patient 2 was 0.13 mSv and the lowest in patient 1 was 0.095 mSv with an average dose received by all patients of 0.11 mSv. Based on BAPETEN regulation No. 6 of 2010, the deterministic threshold for the chance of cataracts is 15 mSv per year, so the range of effective dose values received by the patient is still within safe limits.

Keywords : Radiation Dose, Eye Lens, Panoramic, Thermoluminescence Dosimeter (TLD)

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1. Introduction

Panoramic radiology is a commonly used radiodiagnostic imaging technique in dentistry (Ministry of Health Regulation, 2020; Trikasjono et al., 2015). This examination aims to obtain a clear image of the upper and lower jaws, as well as the surrounding soft tissue, in a single film to aid in the diagnosis of bone abnormalities, tooth position, and sinuses (Linda Ermiza, 2023). During the procedure, the X-ray tube and cassette rotate around the patient. This process produces primary radiation and scattered radiation. This scattered radiation increases the total dose received by the patient, and exposure increases as the body approaches the radiation source (Syafitri et al., 2024).

One of the sensitive organs closest to the radiation path during a panoramic examination is the lens of the eye. Exposure to ionizing radiation on the lens of the eye can cause cell damage and, in high doses, can lead to cataract formation (Syafitri et al., 2024). The lens of the eye is a structure that is very sensitive to radiation (Masdi, 2013). Cell damage to the lens of the eye due to radiation is permanent because the cells are unable to rejuvenate, which can disrupt lens transparency and cause blurred vision that leads to cataracts (Yunus et al., 2019).

Cataracts can progress to cause blindness, although this effect has a latent period (Masdi, 2013). To prevent this deterministic effect, BAPETEN has set a dose limit for the lens of the eye at 15 mSv per year (Head of the Nuclear Energy Regulatory Agency, 2010). The concept of radiation protection states that distance significantly influences dose. Previous research by Syafitri et al. (2024) showed that the dose received by the lens of the eye was greater than that of the thyroid, indicating that the lens of the eye was closer to the radiation source (Syafitri et al., 2024).

Several previous studies have measured the radiation dose to the lens of the eye. Research by Syafitri et al. (2024) found an average dose of 0.08 mGy (Syafitri et al., 2024). Another study by Naserpour et al. (2019) recorded an average dose of 0.155 mGy (Naserpour et al., 2019), while research by Reza et al. (2018) found an average dose of 0.18 mGy (Reza et al., 2018).

Andalas University Hospital (RS UNAND) is one of the healthcare facilities in West Sumatra that offers panoramic radiology services, with a monthly service capacity of 96 patients. Based on this explanation, the author is interested in conducting a specific study on "Measurement of Radiation Dose Received by the Eye Lens in Panoramic Examination Using TLD in the Radiology Installation of RS UNAND."

This study aims to determine the radiation dose received by the eye lens during panoramic examination and whether the dose received exceeds the established dose limit (DTL).

2. Method

This research is a quantitative research with experimental method conducted at the Radiology Installation of Andalas University Hospital in September 2025. The research population was all panoramic examination patients at the location, which in September 2025 amounted to 96 people. From this population, a sample of 7 patients was taken using a non-probability sampling technique with a purposive sampling type.

The instruments and materials used in this study include one unit of Panoramic X-ray Machine (Brand: Carestream, Type: CS 8100SC), a chip-shaped Thermoluminescence Dosimeter (TLD) to absorb radiation, and insulating plaster to attach the TLD.

The research steps involved attaching the TLD to the patient's right and left eyelids using tape. The patient then underwent a panoramic examination with a single exposure using parameters of 73 kV, 10 mA, and 10.8 s. After completion, the TLD was removed from the patient and sent to the Medical Physics and Biophysics Laboratory of the University of Indonesia for reading. The raw data from the TLD reading (in nC units) was processed to obtain the absorbed dose (D) value using the formula, $D = FC \times TL$. Next, the absorbed dose was converted to an equivalent dose (H) using the formula, $H = W_r \times D$, and the final result is the

effective dose (E) calculated using the formula, $E = Wt \times H$, with a tissue weight factor (Wt) for the eye lens of 0.12.

Data analysis was performed by comparing the effective dose results obtained from each sample with the deterministic threshold dose limit (DLT) value for cataract risk based on BAPETEN No. 6 of 2010, which is 15 mSv per year. The data presentation of this study is presented in tabular form and descriptive narrative presentation.

3. Results and Discussion

This study, which examined the radiation dose received by the eye lens during panoramic examinations, was conducted at the Radiology Unit of Andalas University Hospital in September 2025. Data were collected from seven patients. The radiation dose measurement process used a Thermoluminescence Dosimeter (TLD) with exposure parameters of 73 kV, 10 mA, and 10.8 s.

The TLD reading results obtained in nC units are then processed to obtain a calibration factor (FC). The calibration factor is calculated using the formula, $FC = \text{Standard Dose} / \text{TLD Intensity Reading (TL)}$, with a standard dose of 1 mGy. Then the absorbed dose is determined using the formula, $D = FC \times \text{TLD Intensity Reading (TL)}$. From the absorbed dose, the equivalent dose is determined using the formula, $H = D \times W_r$, with a radiation weighting factor for X-rays of 1. The final result is an effective dose obtained using the formula, $E = H \times W_t$, with an eye tissue weighting factor of 0.12.

Table 1. FC Measurement Results

Patient	Standard Dose (mGy)	Right Eye TL (nC)	Left Eye TL (nC)	Right Eye FC (mGy/nC)	Left Eye FC (mGy/nC)
1	1	390,251	413,478	0.002	0.002
2	1	390,251	274,785	0.004	0.004
3	1	390,251	399.01	0.003	0.002
4	1	401,639	341,735	0.002	0.003
5	1	294,144	341,985	0.003	0.003
6	1	453,412	360,813	0.002	0.003
7	1	247,565	247,373	0.004	0.004

Table 2 Results of Absorbed Dose Measurement in Panoramic Examination

Patient	Right Eye FC (mGy/nC)	Right Eye TL (nC)	Right Eye TL (nC)	D Right Eye (mGy)	D Left Eye (mGy)	D Average (mGy)
1	0.002	390,251	390,251	0.78	0.88	0.85
2	0.004	390,251	390,251	1.08	1.1	1.09
3	0.003	390,251	390,251	0.95	0.8	0.87
4	0.002	401,639	401,639	0.8	1.02	0.91
5	0.003	294,144	294,144	0.88	1.02	0.95
6	0.002	453,412	453,412	0.9	1.08	0.99
7	0.004	247,565	247,565	0.99	0.99	0.99

Based on the table above, the highest absorbed dose received by patient 2 was 1.09 mGy and the lowest was received by patient 1 was 0.805 mGy with an average dose received by all patients of 0.944 mGy.

Table 2 Results of Absorbed Dose Measurement in Panoramic Examination

Patient	Right Eye FC (mGy/nc)	Right Eye TL (nC)	Right Eye TL (nC)	D Right Eye (mGy)	D Left Eye (mGy)	Average D (mGy)
1	0.002	390,251	390,251	0.78	0.88	0.85
2	0.004	390,251	390,251	1.08	1.1	1.09
3	0.003	390,251	390,251	0.95	0.8	0.87
4	0.002	401,639	401,639	0.8	1.02	0.91
5	0.003	294,144	294,144	0.88	1.02	0.95
6	0.002	453,412	453,412	0.9	1.08	0.99
7	0.004	247,565	247,565	0.99	0.99	0.99

Table 3 Results of Equivalent Dose Measurements in Panoramic Examination

Patient	D Right Eye (mGy)	D Left Eye (mGy)	wr	H Right Eye (mSv)	H Left Eye (mSv)	H Average (mSv)
1	0.78	0.88	1	0.78	0.88	0.85
2	1.08	1.1	1	1.08	1.1	1.09
3	0.95	0.8	1	0.95	0.8	0.87
4	0.8	1.02	1	0.8	1.02	0.91
5	0.88	1.02	1	0.88	1.02	0.95
6	0.9	1.08	1	0.9	1.08	0.99
7	0.99	0.99	1	0.99	0.99	0.99

Based on the table above, the highest equivalent dose received by patient 2 was 1.09 mSv and the lowest by patient 1 was 0.805 mSv with an average dose received by all patients of 0.944 mSv.

Table 4 Results of Measurement of the Effective Dose of the Eye Lens in Panoramic Examination

Patient	H Right Eye (mSv)	H Left Eye (mSv)	wt	E Right Eye (mSv)	E Left Eye (mSv)	E Average (mSv)
1	0.78	0.88	0.12	0.09	0.1	0.095
2	1.08	1.1	0.12	0.13	0.13	0.13
3	0.95	0.8	0.12	0.11	0.1	0.105
4	0.8	1.02	0.12	0.1	0.12	0.11
5	0.88	1.02	0.12	0.1	0.12	0.11
6	0.9	1.08	0.12	0.11	0.13	0.12
7	0.99	0.99	0.12	0.12	0.12	0.12

Based on the table above, the highest effective dose received by patient 2 was 0.13 mSv and the lowest by patient 1 was 0.095 mSv with an average dose received by all patients of 0.11 mSv.

Discussion

The results of this study successfully identified the magnitude of the radiation dose received by the lens of the eye in 7 patients who underwent panoramic examinations at the Radiology Installation of Andalas University Hospital. Variations in the effective dose received by each individual were found, with the lowest value ranging from 0.095 mSv to the highest value of 0.13 mSv. This variability in findings can be attributed to different patient anatomical factors. Study subjects who received higher identified doses had thinner body postures, while subjects with the lowest doses had relatively fatter body postures. This difference theoretically affects tissue attenuation, with thicker tissue providing greater radiation attenuation. In addition, differences in facial morphology between patients can also change the distance between the X-ray tube and the lens organ of the eye, which in turn affects the amount of radiation exposure received.

The average dose findings in this study, both absorbed dose (0.944 mGy) and effective dose (0.11 mSv), showed higher values when compared to several previous relevant studies, such as those reported by Naserpour et al. (2019) and Reza et al. (2018). This significant difference can be explained by the use of different exposure parameters. The examination protocol at the study site used a relatively higher exposure factor (73 kV, 10 mA, 10.8 s) compared to those used in the comparative studies. This confirms that the exposure factor is a crucial determinant that directly correlates with the radiation dose received by patients, where increasing kV and mAs will increase the energy and number of X-ray photons produced. The main contribution of this finding is to provide data dosimetry empirical

Which specific to the Radiology Installation of UNAND Hospital. The most important point is that, despite dose variations and differences with other literature, the highest effective dose measured in patients (0.13 mSv) is still far below the dose limit (NBD) value, the deterministic threshold for the chance of occurrence of cataract,

Which has The maximum radiation dose (SRP) set by BAPETEN No. 6 of 2010 is 15 mSv per year. These findings quantitatively indicate that the panoramic examination procedure at the facility is very safe and does not pose a risk of deterministic effects on the patient's lens. However, within the framework of developing science and the application of radiological technology, the principle of optimization (ALARA) must remain upheld. Observations during the study identified that the use of specific personal protective equipment such as lead goggles (Pb googles) for patients was not implemented. Although the dose was proven safe, the use of additional protective equipment is highly recommended as an optimization effort to minimize unnecessary radiation exposure to radiosensitive organs such as the lens of the eye.

4. Conclusions and Suggestions

Based on the results and discussion, this study concluded that the effective dose of radiation received by the patient's eye lens during panoramic examination using TLD (Thermoluminescence Dosimeter) varied, with a range of values between 0.095 mSv to 0.13 mSv, and the average effective dose received by all patients was 0.11 mSv. Referring to the objectives of the study, the highest dose received (0.13 mSv) was still within the safe limit and did not exceed the Dose Limit Value (DV) deterministic threshold for the chance of cataracts in the eye lens, which was set at 15 mSv per year based on BAPETEN Regulation No. 6 of 2010. Based on these findings, practical advice that can be given is that even though the dose received is safe, protection for patients is still needed by using protective equipment such as google glasses (lead) to minimize the radiation received by the eye lens. For further research, it is recommended to use a larger number of samples so that the research results obtained can be more optimal

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