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Panoramic X-ray Radiation Exposure Safety Test at ATRO Muhammadiyah Makassar

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A B S T R A C T

Introduction: The radiation safety protocol is an effort made to create conditions so that the dose of ionizing radiation that affects humans and the environment does not exceed the specified limit value. This study aimed to measure exposure to X-ray radiation on panoramic X-rays at ATRO Muhammadiyah Makassar. **Methods:** This research was conducted at the radiology department of ATRO Muhammadiyah Makassar in December 2022. The tools and materials that will be used in this research are dental X-ray planes, survey meters, and perspex phantom, with a thickness of 10 mm, as a substitute for organs in humans. Measurement of the radiation dose exposure in dental X-ray examinations was carried out using an exposure factor of 70 kV, 8 mA at a distance of 1 meter, 2 meters, 3 meters, and 4 meters from various directions, namely front, left side, right side, and back with time. Different exposure on each object. **Results:** The highest dose intensity value was found at 0.25 seconds with a distance of 1 meter in the forward direction with a dosing accuracy of 138.4 (µSv/h). The lowest point is at 0.17 seconds with a distance of 3 meters behind with a dosing accuracy of 0.89 (µSv/h) for an officer who is in the radiation field during irradiation. **Conclusion:** The safe distance for a radiation officer and the general public who must be in the radiation field to assist patients during an examination is 4 meters from the radiation source.

1. Introduction

Ionizing radiation in the form of X-rays and γ-rays are short-wave electromagnetic rays that are widely used in the health sector. The low-energy photons in X-rays and the high-energy photons in γ-rays can alter the normal structure of living cells either directly or indirectly. The direct mechanism involves the disruption of the atomic structure to generate ionized compounds and free electrons. The indirect mechanism involves the radiolysis of water and the formation of free radicals.[1-3]

X-rays can scatter and absorb certain materials. X-rays can discolor film emulsions after chemical processing. X-rays have fluorescence, which causes certain materials such as calcium fungstat or zinculphite to glow (luminescence). X-rays have a biological effect. When exposed to the body will cause biological changes in the tissue. This biological effect can be used in radiotherapy treatment, but if the dose of X-rays is too large, it will have a negative effect on the body.[3,4]

The effect of radiation on human organs depends on the number of doses and the area of the radiation field received.[5] Biological effects that often occur when the body receives too much radiation are skin damage, hematopoietic disorders, malignancy, gene mutations, and chromosomal changes. One example of a radiological examination that utilizes the lowest possible radiation but does not ignore the effects of radiation caused is a panoramic dental examination.[6,7] This examination consists of intraoral and extraoral, which is useful for diagnosing abnormalities suffered by dental patients. The intraoral technique is an irradiation technique carried out on certain parts of the teeth, whereas the extraoral technique is an irradiation technique by taking photos of both the upper and lower jaw as a whole. The X-ray apparatus used is a dental radiography apparatus that produces a low radiation dose to obtain the desired dental organ image.[8]

Radiation used for any purpose, no matter how small, has the potential to be harmful to humans, so radiation safety provisions are necessarily noticed. The radiation safety protocol is an effort made to create conditions so that the dose of ionizing radiation that affects humans and the environment does not exceed the specified limit value.[9] Previous research stated that the highest exposure to X-rays was in the top of the tube at 0.153 mR/hour, while the highest exposure in the X-ray aircraft room was in the computed radiography (CR) operator's room at 0.031 mR/hour.[10] This study aimed to measure panoramic X-ray radiation exposure at ATRO Muhammadiyah Makassar.

2. Methods

This research was conducted at the radiology department of ATRO Muhammadiyah Makassar in December 2022. The tools and materials that will be used in this research are dental X-ray aircraft (specifications for brand MyRay, type RXAC, tube voltage 70 kV, tube current 8 mA, focus 0.8 x0.8 mm, exposure value 0.09-1.61 seconds), survey meter (Specifications for the brand Thermo, model FH 40 G-L, serial number: 42540/0401), and perspex phantom with a thickness of 10 mm as a substitute for organs in humans.

Measurement of the radiation dose exposure in dental X-ray examinations was carried out using an exposure factor of 70 kV, 8 mA at a distance of 1 meter, 2 meters, 3 meters, and 4 meters from various directions, namely front, left side, right side and back with time. Different exposure on each object. Measurements were made 5 times from different distances and directions using Phantom Perspex. The results of measuring radiation dose exposure were measured using a survey meter. Research data are presented in tables and narratives.

3. Results and Discussion

In dental X-ray examination, there are several influencing factors, namely voltage (kV), current (mA), and exposure time (s). In examining panoramic photos using X-rays, the voltage and current cannot be adjusted as can be done with other radiographic equipment. In dental X-rays, the factors that play an important role in determining the radiation dose exposure are exposure time, distance to the X-ray radiation, and direction.[11-13]

At the first inspection, given an exposure time of 0.13 seconds with the same distance and time and the same direction different carried out 5 (five) times irradiation obtained variations in exposure to different radiation doses (Table 1). At a distance of 1 meter, an exposure of 45.3-84.94 (μSv/h) is obtained, while at a distance of 2 meters, an exposure of 11.4-29.51 (μSv/h) is obtained, while at a distance of 3 meters, no radiation dose exposure is found.

Table 1. Results of measurements of dental X-ray radiation exposure at 0.13 seconds.

Time (seconds)	Distance (meters)	Direction	Exposure (μSv/h)
0,13	1	Front	84.94
		Left side	75.4
		Right side	61.84
		Back	45.3
	2	Front	29.51
		Left side	18.06
		Right side	12.3
		Back	11.4
	3	Front	0
		Left side	0
		Right side	0
		Back	0

In the second examination, an exposure time of 0.17 seconds was given with the same distance and time and in different directions. These were carried out 5 (five) times with variations in exposure to different radiation doses (Table 2). At a distance of 1 meter, the exposure is 61.3-102.11 (μSv/h). At a distance of 2 meters, the exposure is 14.3 (μSv/h) to 31.27 (μSv/h) at a distance of 3 meters. The exposure is 0, 89 (μSv/h) to 1.56 (μSv/h), while at a distance of 4 meters, no radiation dose exposure was found.

Table 2. Results of measurements of dental X-ray radiation exposure at 0.17 seconds.

Time (seconds)	Distance (meters)	Direction	Exposure (μSv/h)
0,17	1	Front	102.11
		Left side	80.9
		Right side	72.3
		Back	61.3
	2	Front	31.2
		Left side	21.17
		Right side	19.2
		Back	14.3
	3	Front	1.56
		Left side	1.49
		Right side	1.32
		Back	0.89
	4	Front	0
		Left side	0
		Right side	0
		Back	0

In the third examination, an exposure time of 0.21 seconds was given with the same distance and time and in different directions, carried out 5 times (Table 3). At a distance of 1 meter, the exposure is 74.3-114.14 (μSv/h). At a distance of 2 meters, the exposure is 15.4-51.5 (μSv/h). At a distance of 3 meters, the exposure is 1.03-1.90 (μSv/h). While at a distance of 4 meters, there is no longer any exposure to radiation doses.

Table 3. Results of measurements of dental X-ray radiation exposure at 0.21 seconds.

Time (seconds)	Distance (meters)	Direction	Exposure (μSv/h)
0.21	1	Front	114.14
		Left side	99.3
		Right side	89.3
		Back	74.03
	2	Front	51.5
		Left side	27.02
		Right side	17.02
		Back	15.4
	3	Front	1.9
		Left side	1.86
		Right side	1.75
		Back	1.03
	4	Front	0
		Left side	0
		Right side	0
		Back	0

In the fourth examination, an exposure time of 0.25 seconds was given with the same distance and time and in different directions, which were carried out 5 times (Table 4). At a distance of 1 meter, the exposure is 91.98-138.4 (µSv/h). At a distance of 2 meters, the exposure is 15.96-68 (µSv/h), and at a distance of 3 meters, the exposure is 1.14-2.82 (µSv/h).

Table 4. Results of measuring dental X-ray radiation exposure at 0.25 seconds.

Time (seconds)	Distance (meters)	Direction	Exposure (µSv/h)
0,25	1	Front	138.4
		Left side	112.6
		Right side	108.4
		Back	91.98
	2	Front	68
		Left side	28.1
		Right side	22.6
		Back	15.96
	3	Front	2.82
		Left side	2.69
		Right side	2.50
		Back	1.14
	4	Front	0
		Left side	0
		Right side	0
		Back	0

The highest dose intensity value was found at 0.25 seconds with a distance of 1 meter in the forward direction with a dosing accuracy of 138.4 (µSv/h). The lowest point is at 0.17 seconds with a distance of 3 meters behind with a dosing accuracy of 0.89 (µSv/h) for an officer who is in the radiation field during irradiation.

Time is one of the factors that influence the amount of radiation exposure received by a person, both the officer and the patient. Preventing this can be avoided by reducing the time at the radiation source by using personal protective equipment (PPE) when carrying out tasks in the radiation field. Radiation officers who are in the radiation field will receive a radiation dose that is proportional to the length of time the officer is in the radiation field.

Table 5. Radiation exposure in the environment around the source.

No	Position	Distance from source (meters)	Exposure (µSv/h)
1	Officer room	4	0
2	Ultrasound room	6	0
3	Patient waiting room	4	0

Based on radiation exposure data in the room around the X-rays, the radiology room design is declared safe (Table 5). A room design that basically uses gypsum and concrete as a divider between the radiology room and the room surrounding coated with Pb with a thickness of 2 mm in accordance with the provisions of the International Commission for Radiological Protection (ICRP) radiation protection program.

Safe working conditions must follow the radiation protection principles set by the ICRP in the use of nuclear engineering in various fields of activity. Radiation protection refers to three basic, namely justification or justification, optimization, and limitation of dose acceptance.[14] To meet basic in this optimization, three basic philosophies of radiation protection were introduced, namely setting the time when in a radiation area, setting a safe distance to radiation sources, and using radiation shields.[15] The basis of radiation protection refers to setting time and distance, which is a very simple way to suppress radiation exposure while carrying out duties, and both can be carried out by every officer, even if only with simple radiation protection facilities.

4. Conclusion

The highest dose intensity value was found at 0.25 seconds with a distance of 1 meter in the forward direction with a dosing accuracy of 138.4 (μSv/h). The lowest point is at 0.17 with a distance of 3 meters behind with a dosing accuracy of 0.89 (μSv/h) for an officer who is in the radiation field during irradiation. The safe distance for a radiation officer and the general public who must be in the radiation field to assist patients during an examination is 4 meters from the radiation source.

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