Parameters of Dental X-Ray Exposure in Dental Patient Absorbed Dosage Calculation

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Abstract. A dental x-ray is an x-ray used for checking teeth. During the inspection process, the patient will receive the dose resulting from the function of the formation of x-rays. To know the magnitude of the dose, the radiation measurement tool required, and any instances of the hospital do not have it. To see the magnitude of the dose, a radiation measurement tool was needed. In many cases, the hospital did not have it, so the hospital had to borrow instruments to measure the radiation. With these problems, the purpose of this research is to know the value exposed parameters and can calculate the weight of the absorbed dose without the use of tools to measure the radiation. Using the equation of exposure then, it can calculate exposed parameters and then know the absorbed dose received by the patients teeth. This research was conducted with fifteen tools and dental x-rays with various merk and types. The fifteen tools will have a value of expose parameters that is different because it depends on the voltage waveform, the filtration, and the beam size used. This research is done by placing the proper dose measurement tools under the CONUS cylinder. The radiation measurement tool will connect to the computer with ocean applications that read the dose number. In the process expose, wich in the set is expose time. The greater the time hence, the larger the dose also accepted. And obtained a value of expose parameters minimum of 2,109, while the value tells parameters maximum of 21,937.

PRELIMINARY

The intraoral examination technique is an irradiation technique by taking photos of certain parts of the teeth. This examination technique uses the ability of X-ray radiation to produce images of dental organs, and a particular radiation dose is required to image the tooth structure of orthodontic patients. Therefore, medical physicists need to check the radiation dose emitted by the dental x-ray radiograph received by the patient. To find out the magnitude of the dose received by the patient, can be determined using a radiation measuring device owned by the Surabaya Health Facilities Security Agency (BPFK), but to find out the magnitude of the dose received by a patient without using a radiation measuring device cannot be due to not knowing the value of the dental exposure parameter x-ray. Hospitals have different brands and types.

The exposure parameter is a value owned by a dental x-ray device, making it easier to determine the absorbed dose received by a dental patient without using a radiation measuring device. Meanwhile, the importance of the absorbed dose is how large the dental patient receives the dose during a dental x-ray examination. Knowing the value of the exposure parameter will make it easier to calculate the absorbed amount received by dental patients without using a radiation measuring device.

Based on the description of the problem above, it is essential to know the exposure parameter value of each dental x-ray device. If you see this value, you can find out the absorbed dose the patient has received without using a dose-measuring device.

BASIC THEORY

The radiation intensity is a value that indicates the amount of radiation emitted per second at a position, whether produced by radioisotopes or other radiation sources such as electron beam machines, X-ray machines, and accelerator machine nuclear reactants (LINAC) (Bapeten, 2011). Radiation intensity (I) has an inverse relationship with the square of the distance

(d) from the source to the patient's position, and the radiation intensity is proportional to the tube voltage (V), exposure time (s), and tube current (mA) so that the radiation intensity can be written as follows (WJ Meredith, 1977).

$$I = \frac{V^2 It}{d^2} \qquad (1)$$

Exposure (Exposure) is a quantity to express the intensity of X-rays which can produce ionization in the air in a certain amount, so Exposure (X) can be formulated by (WJ Meredith, 1977):

$$X = k\frac{V^2 It}{d^2} \qquad (2)$$

where X = exposure (mR), k = parameters dental x-ray exposure (mGy kV Jm)/cm^2, V = voltage (kV), I = current (mA), t = irradiation time (s) and d = SSD = distance from source to skin (cm).

Absorbed dose is the amount of radiation energy absorbed or received by the material in its path. The relationship between absorbed dose and exposure is as follows (Bapeten, 2011):

$$D = f.X \qquad (3)$$

where D = absorbed dose (Rad), f = conversion factor from exposure rate to dose rate absorbance (Rad/R), and X = exposure (R). If the medium used is air, then, f = 0.877 (Rad/R) (Bapeten, 2011).So that to calculate the absorbed dosewith the following equation:

$$D = k\frac{V^2 It}{d^2}.0.877 \,.\, 10^{-2} \qquad (4)$$

With h = absorbed dose(mGy), k = dental x-ray exposure parameters (mGy kV mJ)/cm^2, V= voltage (kV), I = current (mA), t = irradiation time (s), and d = SSD = distance from source to skin (cm).

To find out the parameter values of dental x-ray exposure using the linear regression equation, where the absorbed dose is measured as a function of y and time as a function of x, namely:

$$y = mx + n$$

$$k = \frac{md^2}{0.877 \,.\, 10^{-2} V^2 I} \qquad (5)$$

RESEARCH METHODS

Place and time of research

This research was conducted at RSGM Airlangga University and BPFK Surabaya in September - December 2017.

Research Tools and Materials

The tools used in this study were dental x-rays, detectors, meters, laptops, and objects.

Research procedure

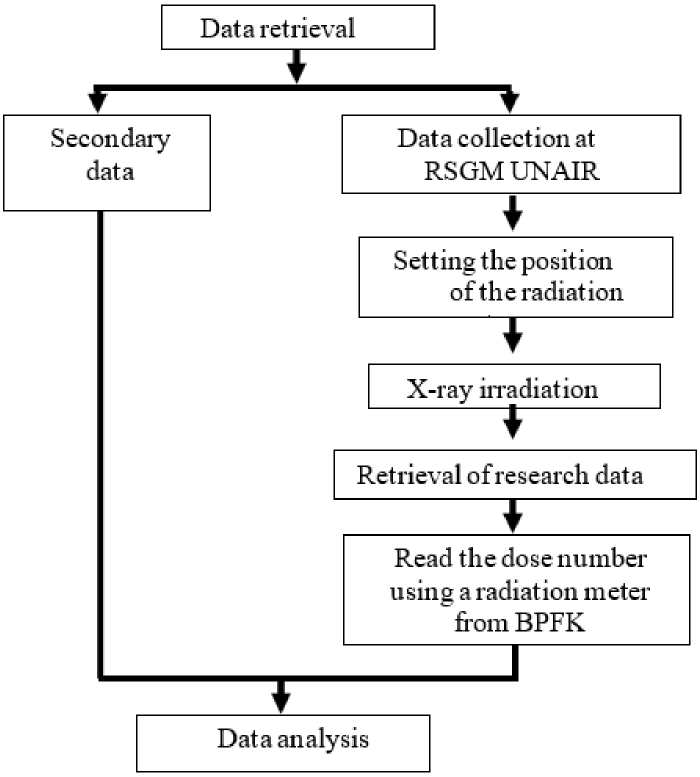

FIGURE 1. Research procedure

This research was conducted without using patients, but the treatment was like using patients. The data collection was carried out in two places

namely BPFK Surabaya and RSGM Airlangga University. BPFK collects secondary data, namely data obtained from the results of conformity tests carried out by BPFK. In RSGM, to collect primary data. The data collection was carried out by placing the radiation measuring instrument just below the CONUS cylinder, then varying the time (s) in the control table. After that, do the irradiation to obtain the absorbed dose value (mGy) read by the radiation measuring instrument. The data collection was carried out four times with various irradiation times. The results of these readings will appear on the laptop when reading the dose numbers after X-ray irradiation. Then measure the distance from the source to the skin (SSD) (cm).

RESULTS AND DISCUSSION

This study aims to determine the exposure parameter values of dental x-ray devices with various brands and types to calculate the absorbed dose received by patients without using radiation measuring devices. To find out the exposure parameter (k) is obtained Equation (5) can be shown in the following Table 1.

Table 1. Exposure parameter values (k) of various brands and types of dental x-ray devices

No	Tube Brand	Type	No. series	*k*
1.	Toshiba	D-0711	EH-09J0556	15,186
2.	Toshiba	D-0711	EH-1110022	14,827
3.	Osada	OX-P11	P-941637	21,937
4.	Sirona	CEI OX-70P	820320	5,931
5.	trophy	TRX-708	1341278	11.312
6.	Gnatus	Raios X Timex 70C	4663041008	2,109
7.	Toshiba	D-082B	2L56287	3,595
8.	Villas	OX-70	641331	3,508
9.	CEI	OCX-70G	1040353	9,116
10.	CEI	OCX-65	750459	6,946
11.	Toshiba	D-0711	T-04589	16,863
12.	trophy	TRX-708	0820169	11,596
13.	CEI	OCX-70G	730858	8,068
14.	Toshiba	D-0711	EH-11C0674	15,744
15.	Toshiba	D-0711	EH-10L0690	15,159

From the data above, there are several dental x-ray devices with the same brand and type that have different k values, namely:

Table 2. Exposure parameter values for the Toshiba brand with type D-0711

No	Tube Brand	Type	No. series	Waveform (pulse)	Filter(mmAl)	*k* $(\frac{mGy\ kV\ ml}{cm^2})$
1	Toshiba	D-0711	EH-09J0556	Med/HF	2	15,186
2	Toshiba	D-0711	EH-1110022	1	2	14,827
3	Toshiba	D-0711	T-04589	6/12	2	16,863
4	Toshiba	D-0711	EH-11C0674	1	2	15,744
5	Toshiba	D-0711	EH-10L0690	1	2	15,159

From these data, it is clear that the exposure parameter value (k) of the dental x-ray is different because the waveforms are different. (WJ Meredith, 1977) The exposure parameter depends on the waveform, filter, and beam size.

The same waveforms and filters exist, but the k values are different. This is because the production years for generators and X-ray control panels are different, namely:

Table 3. Differences in the k values for the Toshiba brand type D-0711 with different years of production

No	Tube Brand	Type	No. series	Waveform (pulse)	Filter(mmAl)	Production year	*k* (mGy kV mJ)/cm2
1	Toshiba	D-0711	EH-1110022	1	2	2008	14,827
2	Toshiba	D-0711	EH-10L0690	1	2	2010	15,744
3	Toshiba	D-0711	EH-11C0674	1	2	2011	15,159

X-rays that the components of the x-ray generator and filter change. In this case, the researcher did not measure the resulting waveform and did not measure the light-ray filter. x generated so that researchers cannot be sure that the waveform generated is one pulse and the filter used is two mmAl. With different k values, the average k values with standard deviations are obtained as follows: Table 4 Exposure parameter values (k) for the Toshiba brand with type D-0711.

Table 4. Exposure parameter values (k) for the Toshiba brand with type D-0711

No	Tube Brand	Type	No. series	*k* (mGy kV mJ)/cm2
1	Toshiba	D-0711	EH-1110022	14,827
2	Toshiba	D-0711	EH-11C0674	15,744
3	Toshiba	D-0711	EH-10L0690	15,159
		Average		15,243
		Standard deviation		0.464

With the difference in the value of k on the Toshiba brand and type D-0711, an average k value of 15.243 ± 0.464 is obtained (mGy kV mJ)/cm^2.

In addition, there are dental x-ray aircraft with the same brand and type, namely:

Table 5. Exposure parameter values for CEI brand and OCX-70G type

No	Tube Brand	Type	serial no	Wave Shape ng	Filter(mmAl)	*k* (mGy kV mJ)/cm^2
1	CEI	OCX -70G	1040353	1 pulse	2	9,116
2	CEI	OCX-70G	730858	med /HF	≥ 2	8,068

The table above shows that the waveforms and filters owned by the CEI brand and the OCX-70G type differ. According to Meredith and Massey, the exposure parameter values depend on the waveform, filter, and beam size used.

After knowing the exposure parameter value (k) of each dental x-ray device with various brands and different types, it is possible to calculate the absorbed dose using equation (4). Where the calculated absorbed dose value of the measured absorbed dose has been carried out, a linearity test. The linearity test shows that the greater the estimated absorbed dose, the greater the measurable absorbed dose. There is a linearity value equal to one ($R2 = 1$) on the dental x-ray aircraft brand Toshiba and type D-0711.

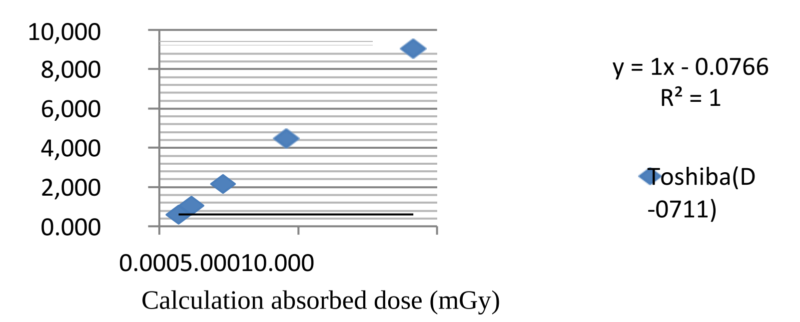

FIGURE 2. Calculation absorbed dose

CONCLUSION

Based on the research that has been done, it can be concluded as follows:

1. Knowing the measured absorbed dose can calculate the parameter values of dental x-ray exposure with various brands and types. The exposure parameter value for the Toshiba brand type D-0711 is 15.243; brand Osada type OX-P11 of 21,937; brand Sirona type CEI OX-70P of 5,931; TRX-708 type Trophy brand of 11,312; brand Gnatus type Raios X Timex 70C of 2.109; brand Villa type OX-70 of 3,508; brand CEI type OX-70G of 9.116; brand CEI type OCX-65 of 6,946; Brand CEI type OCX-70G of 8,068. Exposure parameters depend on the waveform, filter, and beam size used.
2. By obtaining dental x-ray exposure parameter values from various brands and types, it is possible to calculate the absorbed dose value received by the patient without using a radiation measuring device.

REFERENCES

1. Bapeten. (2011). Radiation Safety in the Use of X-Ray EquipmentDiagnostic Radiology Andinterventional.Jakarta: Bapeten.
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