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Quality Control Parameters of Illumination, Collimation and Half Value Layer on X-Ray General Radiography and Mobile Radiography

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ABSTRACT

Quality control on diagnostic x-ray radiography general and radiography mobile very important and maintenance. Quality control x-ray general purpose and radiography mobile parameter same illumination, collimation and half value layer. Test illumination using lux meter, measured collimation using collimator test tool. The results showed the illumination in the general radiography and mobile radiography were ≥ 100 Lux. Measured collimation using collimator test tool, collimation test on general radiography was 2% while in mobile radiography was 3%. Measurements of X-ray half value layer (HVL) on general radiography and mobile radiography were performed at 70 kV and 80 kV and fixed current of 20 mAs. X-ray beam quality in general Radiography at 70 kV inherent filter voltage of 2.36 hvl and dose of 0.8831 mGy while on mobile radiography filter inherent 2.65 hvl and dose of 1,114 mGy. X-ray beam quality in general radiography at 80 kV inherent filter 2.70 hvl and dose of 1,133 mGy, whereas in radiography mobile filter inherent 2.99 hvl and dose of 1.4630 mGy.

Keywords : General radiography, mobile radiography, illumination, collimation, half value layer (hvl).

I. INTRODUCTION

Utilization of radiation widely used, especially in the field of health services useful for diagnosis of a disease [1]. The radiation used in the field of radiology to diagnose a disease using X-ray [2]. This is because X-rays have a short wavelength (1Å = 10^{-8} cm) so that the high translucency [3]. It will indirectly contribute radiation derived from artificial radiation sources to patients [4]. The X-ray plane of radiologhy commonly used for radiological processes is divided into general and mobile radiologhy[5]. General radiology has been installed indoors so that it can not be moved, whereas mobile radiology can be moved and have either used a charger battery or can be connected using a power supply.

The common problems that occur in radiological X-ray are illumination irregularities, irregularity of collimation field with radiation beam, irregularities of radiation beam and collimator inaccuracy over the vast field of X-ray beam. Therefore, this study leads to testing some of these parameters as a comparison for quality control activities in general radiology X-ray and mobile radiology X-ray devices.

II. METHODOLOGY

Test of all begins with observations of general X-ray radiography and mobile X-ray radiography at Sari Mutiara Hospital Medan. Further preparation of equipment such as general X-ray, X-ray mobile radiography, light meter, Collimator, beam alligment test tool, piranha detector, waterpass, radiographic film and measuring sheet. After the equipment is available, the measurement of general radiography and mobile radiography with illumination, collimation, half value layer, and X-ray beam parameters are required.

III. RESULTS AND DISCUSSION

Illumination Test

The results of the illumination test on a general radiography at a distance of 100 cm from the X-ray tube were measured at four measuring points and repeated five times. Illumination test data for general radiography can be seen in Table 1.

The first measurements have an average measuring point 159.75 Lux and the results of the first illumination test are 108.75 Lux, at the second measurement of the average 161.00 Lux measuring point and the second illumination test result is the second 110.00 Lux, on the third measurement of the average 160.75 Lux measuring point and the third illumination test result is 109.75 Lux, at the fourth measurement the average 160.75 Lux measuring point and the fourth illumination test result is 109.75 Lux, on the fifth measurement of the average measuring point 160.25 Lux d the fifth illumination test result was 109.25 Lux. To get the result of illumination the following equations are used:

Illumination (Test Result) = Mean of Lux Measured - Lux Background (1)

With escaped test value ≥ 100 lux

Then the illumination test is done on mobile X-ray radiography. The results of the illumination test on the mobile radiography can be seen in Table 2.From the results of the illumination test on the General Radiography at a distance 100 cm from the X-ray tube is measured at four measuring points and carried out repeated five times.

Table 1. Illumination Measurement Results for X-Ray General Radiography

Illumination Measurement Area (Lux)	Measurement Point				Average	Light Room (Lux)	Test Result (Lux)
	Area I	Area II	Area III	Area IV			
1	168	148	166	157	159,75		108,75
2	167	149	169	159	161,00		110,00
3	168	147	170	158	160,75	51	109,75
4	169	146	168	160	160,75		109,75
5	169	147	167	158	160,25		109,25
Pass Value ≥ 100 Lux							

Table 2. Illumination Measurement Results for X-Ray Mobile Radiography

Illumination Measurement Area (Lux)	Measurement Point				Average	Light Room (Lux)	Test Result (Lux)
	Area I	Area II	Area III	Area IV			
1	148	175	173	177	168.25		100.25
2	171	172	173	172	172,00		104,00
3	170	171	174	174	172,25	68	104,25
4	172	171	173	174	172, 50		104,50
5	171	172	172	173	172.00		104.00
Pass Value ≥ 100 Lux							

Table 3. Results of Collimation Test for General Radiography

Point	Edge of Light (cm)	Edge of X-ray (cm)	|Δ1|+|Δ2|(% SID)	ΔX + ΔY (% SID)
X1	9	9	0.5	2
X2	9	8.5		
Y1	7	6	1.5	
Y2	7	6.5		
Pass Value ≤ 3%				

Table 4. Results of Collimation Test for Mobile Radiography

Point	Light Wipe Edge (cm)	Edge of X-ray Lap (cm)	|Δ1|+|Δ2| (% SID)	ΔX + ΔY (% SID)
X 1	9	8	1.5	3
X 2	9	8.5		
Y 1	7	6.5	1.5	
Y 2	7	6		
Pass Value ≤ 3%				

The first measurement was the average of measuring point 168.25 Lux and the first illumination test result was 100.25 Lux, on the second measurement of the average of 172.00 Lux measuring point and the second illumination test result was 104.00 Lux, the measuring point 172.25 Lux and the third illumination test result is 104.25 Lux, on the fourth measurement of the average 172.50 Lux measuring point and the fourth illumination test result is 104.50 Lux, on the measurement of the fifth average of the measuring point Lux 172.00 and the fifth illumination test result is 104,00 Lux.

From above, it is shown that the illumination rate generated by the collimator on five tests for both general X-ray and mobile X-ray devices has passed the test because of the average yield of the measuring point of each measurement of 100 Lux.

Collimation Test

Testing of collimation and stiffness of X-ray beam with light of collimator. Measurements were made on the general radiologhy by regulating the edge of the field of light on the axis X_1 = 9 cm and the edge of the field of X-ray = 9 cm, on the X $axis_2$ edge airy light = 9 cm and the edge of the field of X-ray = 8,5 cm. On the $Y\text{-}axis_1$ of the periphery of light = 7 cm and the edge of the X-ray field is 6 cm, at Y_2 the setting of 7 cm wide rim of light and the X-ray edge of the field is 6.5 cm. The results of general radiography X-ray collimation test can be seen in Table 3 below.

To obtain the difference of field collimation with X-ray beam on the X axis is obtained using the equation below:

$$\Delta X\ (\%\ SID) = \frac{[X_1] + [X_2]}{SID}\ x\ 100\% \quad (2)$$

The % SID value deviation on the x axis is 0.5%.

The difference of the field of collimation with X-ray beam on the Y axis is obtained by the equation below:

$$\Delta Y\ (\%SID) = \frac{|Y_1| + |Y_2|}{SID}\ x\ 100\% \quad (3)$$

The SID deviation value is 1.5%.

The sum of the field difference of collimation with X-ray beam on the X-axis and Y-axis is derived from the equation below:

$$\Delta X + \Delta Y = |\Delta X|(\%SID) + |\Delta Y|(\%SID) \quad (4)$$

So that the sum of the field difference collimation with X-ray beam on the X-axis and Y-axis is 2% .

The tolerance limit passes the test is

ΔX and $\Delta Y \leq 2\%$ SID

$$\Delta X + \Delta Y \leq 3\% \text{ SID} \quad (5)$$

Collimation test is also performed on the mobile radiography. Measurements were made by adjusting the light field edge axis X_1= 9 cm and the edges of the X-ray field = 8 cm, on the X axis$_2$ edge = 7 cm light airy and roomy but the X-ray = 8.5 cm. On the Y-axis$_1$ of the field edge of light = 7 cm and the edge of the X-ray field is 6.5 cm, at Y_2 the setting of the field of light = 7 cm and the edge of the X-ray field is 6 cm. The results of the collimation test on the mobile radiography can be seen in Table 4.

So it can be said that the difference of field collimation with X-ray beam in general and mobile radiography is X axis and Y axis is still under tolerance limit so that the equipment is still feasible to use.

Quality of X-ray Beam

Quality of beams is shown in graphical form for general radiography and mobile radiography using 70 kV and 20 mAs voltages with filter variations shown in Figure 1.

The quality of beam (HVL) on general radiography with an inherent 1.2 mmAl filter produces quality of beam (HVL) of 2.36 HVL while on the inherent mobile radiography of 5 mmAl measured 2.65 HVL at a voltage of 70 kiloVolt and 20 mAs. This test indicates that inherent filters for general and mobile radiography produce low beam quality. The thicker filter used is the higher measured quality of beam (HVL) and received dose of radiation decreases as low X-rays can not penetrate the material.

In addition, quality of beam comparisons are also made for general and mobile radiography using 80 kV and 20 mAs voltages with filter variations shown in Figure 2.

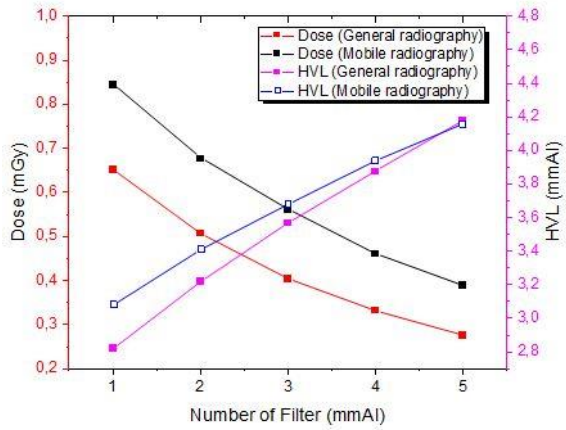

Figure 1. Comparison of quality X-ray beam for General and Mobile Radiography using 70 kV and 20 mAs

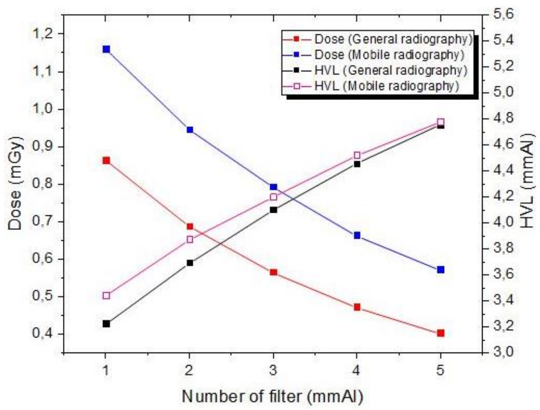

Figure 2. Comparison of X-ray beam General and Mobile Radiography using 80 kV and 20 mAs

Figure 2 above shows that at a voltage of 80 kV and 20 mAs on a general radiography with an Inherent 1.2 mmAl filter produces a measurable beam quality of 2.70 HVL and a measured dose of 0,8831 mGy, while on mobile radiography with Inherent filters of 5 mmAl and quality of beam 2.99 HVL measured radiation dose of 1.4630 mGy.

When the thick of filter increased and the quality of beam measured increased (HVL) it will reduced radiation dose. Increased tube voltage results in greater radiation dose at 80 kV. Doses can be optimized by adding Adherent filters on general and mobile radiography. Figure 2 shows the general and mobile radiography passing the test because there is not additional filter at 80 kV with 20 mAs shows the quality of the beam of 2.65 HVL while the standart value is ≥ 2.3 for filterless.

The quality of beam resulting for general radiography is lower than the quality of the mobile radiography. This is because the inherent filters on the general radiography are smaller than the inherent filters of the mobile radiograph. The greater quality of beam measured then the resulting image quality is better because there is no blurring on the radiographic image. When the low quality of beam is missed then will be disturb of radiographic image so it can be interfere with the diagnosis.

IV. CONCLUSION

From the results of the illumination Test on general and mobile radiogrphy pass the test because the results of illumination test ≥ 100 Lux. Testing the quality of X-ray beam (HVL) produced by general radiography and mobile radiography variation of tube voltage of 70 kilo Volt, 80 kilo Volt and 20 mAs. From the filter variations used, the filter that used increased, radiation dose increased, and the filter increased cause the radiation dose is decreased and the the quality of the beam will increased. It will conclude that the both of radiography is still on tolerance limits.

V. ACKNOWLEDGMENT

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