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The comparison of density value in radiograph with using ink-jet film and dry film computed radiography (CR)

Anak Agung Aris Diartama*[1], Rachel Monica Deovania Moningka[1], I Bagus Gede Dharmawan[1], Triningsih[2]

[1]*Department of Radiologic Imaging Technology, ATRO Bali, Denpasar, Bali, Indonesia*
[2]*Radiology Department, Sanglah Hospital, Denpasar, Bali, Indonesia*

***Corresponding Author: Anak Agung Aris Diartama**
Email: arisdiartama@atro-bali.ac.id

ABSTRACT

Background

The revolution in the health sector is developing very rapidly and is constantly producing new innovations that have various benefits in the world of health, one example is in the Radiology unit. The output results in a radiological examination are radiographs. The factors that used to evaluate the quality of a radiograph to produce an optimal image include a density, contrast, sharpness and detail. Computed radiography (CR) is one of the modalities which integrated with a computerized system that is widely used in the field of radiology unit today. One of the devices in a CR system that can function in issuing the output form in the form of a radiograph is a CR laser printer using a dry film. Using a dry film along with a CR laser printer must be reviewed because of the high costs of equipment and maintenance. At present re-developed ink-jet film whose image output process can use an ink-jet printer at a lower cost than using a dry film laser printer. studies about the quality of the radiograph for the differences between ink-jet film with dry film radiography is not yet known before.

Aims

To determine the difference in radiographic of the density value by using ink-jet film and dry-film computed radiography (CR), and to analysed the value of a more optimal density.

Methods

This Research uses quantitative analytic research with an experimental approach. Statistical analysis is a paired t-test if the data is normally distributed, but if the data is not normally distributed it will use the Wilcoxon test.

Result

The statistical test using Wilcoxon shows that the p-value is 0,000 whose indicates that H0 is rejected and Ha is accepted, which means there is a difference of density values between dry Film CR and ink-jet film. Dry film shows the optimal density results seen from the mean rank higher than the ink-jet film.

Conclusion

There is a difference of the density value between dry film CR and ink-jet film, where the optimal density value is indicated by dry film CR.

Keywords: Radiograph, Density, Step wedge, Ink-jet Film, Dry Film, Computed Radiography

INTRODUCTION

X-rays are invisible rays in the frequency band between $3x10^{16}$ Hz to $3x10^{19}$ Hz and energy bands between 100 eV to 100 keV in the electromagnetic wave spectrum. Under these conditions, an X-ray is considered able to be used as one of the energy that can help enforce the diagnosis because it can show the internal parts of the human body without any invasive procedures. The body parts can be shown on a radiographic film that serves as an image recording medium after X-rays passing through an object [1], The results of the process image must demonstrate quality information and can be assessed by a physician in determining the conditions of the patient so that patients get the right treatment, for that there are several factors used to evaluate the quality of a radiograph in order to produce the optimal image which is density, contrast, sharpness, and detail.

Density is the level of blackness or the amount of light absorbed in certain areas contained in the film caused by the emission of visible light or X-rays of the grains of silver halide as the constituent of the film emulsion the density will be directly proportional to the significant exposure factor, if the radiation intensity is high the value of density will be high [2]. The difference in degree of blackness between adjacent areas on a radiograph is called contrast [3], while the sharpness of the image can show the thickness of the transitional boundary between the two different density areas or in other words a radiograph is said to be sharp if it can show a clear line between the parts of the object in the radiograph [4]. Contrast is the sharpness of detail that can describe the smallest structures of the object on a radiograph [5].

A radiograph will be said to be feasible and good if all the four factors are displayed properly on the radiograph produced. Another factor that can support the formation of a quality image can be a modality with a sophisticated and adequate computerized system. This is closely related to computed radiography (CR) which is one of the modalities which integrated with a computerized system used in the field of radiology. Principally, computed radiography (CR) is in the form of an image digitization process that converts analogue systems on conventional radiography to digital radiography, which uses sheets or photostimulable plates for image data acquisition [6].

The image produced by a computed radiography (CR) device can be used to assist an action in establishing the diagnosis. Therefore, all devices from computed radiography (CR) must function according to established standards. The good image quality will provide a good diagnostic value, because no information is lost or invisible due to poor image quality [7]. One of the devices in a computed radiography (CR) system that can function in issuing a radiographic output form is a laser computed radiography (CR) printer using a dry film made from polyester or cellulose acetate, but the use of dry film along with a laser computed radiography printer (CR) must be reviewed because the equipment and maintenance that require a fairly high costs [8].

This can be an obstacle for hospitals in remote areas that are still lacking in human resources and inadequate medical equipment in providing optimal health services to patients, the same thing will have an impact on patients with a low economy that is not have health insurance. To overcome these problems, several hospitals or other health institutions related to the radiology unit have redeveloped the use of ink-jet printers along with ink-jet films from basic polyethylene terephthalate materials that can be used specifically for print a radiographic results, at a costs cheaper, practical to carry anywhere and easy to obtain when it compared with laser computed radiography (CR) printers using a dry film.

In this study, will observe the differences of density value to radiographs with using ink-jet film and dry-film computed radiography (CR) to objects step wedge. The use of ink-jet printers compared to brand A laser printers is to determine the difference in output quality produced by the two types of printers has also been investigated by comparing Thorax objects [9]. The use of ink-jet printer to print radiographs using HVS paper in making diagnoses can also be performed [10].

METHODS

This research uses a quantitative analytic research with an experimental approach which is carried out by analysing the density value on ink-jet film and dry film computed radiography (CR). The statistical analysis used in this study was paired t-test if the data were normally distributed, but if the data were not normally distributed then

the Wilcoxon test would be used. this study will be conducted at the Laboratory of ATRO Bali (Academy of Engineering Radiodiagnostic and Radiotherapy Bali) and the object in this study use a step wedge with 21 levels in comparing density values to ink-jet film and dry film CR. The research sample used was 21 levels of measurement from 3 radiograph results using ink-jet film and dry film CR in comparing the density values.

The research was conducted by exposing the object using a step wedge with IS and CR tools. setting the parameters such as FFD (Focus Film distance) of 100 cm, the CR (central ray) vertical upright, CP (central point in mid-step wedge precisely on the 11th step, adjusting the beam area according to the area of the step wedge by giving the field wide spacing distance) irradiation of approximately 1 cm from each side of the step wedge Exposure factor is set with KV 55, mA 100 and s 3.2 and the exposure is carried out.

Figure A

Figure B

Adjustment 21 step of step wedge on IS and collimation setting are shown in Figure A and the X-ray tube setting is shown in Figure B.

After the image plate (IS) is exposed, scan with the image reader CR. Repeat the things for 3 times. The results of the scan that has been scanned with an image reader will appear on the CR monitor screen without doing any editing to the object view on the monitor computed radiography (CR) and will be print using a Printer. The three radiograph will be print with using ink-jet film on the ink-jet printer and The three dry film will using CR printer. After obtaining three step wedge radiographs from each kind of ink-jet and dry film, then density measurements were taken on each radiograph using a densitometer.

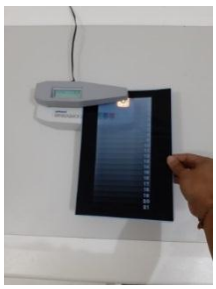

Figure C

Figure D

Measurement of density with a densitometer is shown in Figure C. There are 21 steps of the difference in density values in 1 radiographic film, so that measurements are taken for 3 times in each step, which are on the left, centre and right then count for the average value, as shown in Figure D After obtaining the measurement value of the density of the entire film, the data were analysed using statistical tests

RESULT

This research is an early stage research conducted by comparing the density values between dry film CR and ink-jet film by using an object in the form of a step wedge with 21 levels measured using a densitometer. The study was conducted in January 2020.

Figure E

Figure F

Figure E is a results from dry film CR radiographs and figure F is a result from ink-jet film radiographs.

Normality test analysis is done to assess whether the data is normally distributed or not, so that the statistical test can be determined.

Table 1. Normality Test of each Variable

	Kolmogorov-Smirnov[a]	
Variable	**ρ Value**	
Density Value on Dry Film	0,017 (ρ > 0,05)	Data is Not Normal
Density Value on Ink-jet Film	0,000 (ρ < 0,05)	Data is Not Normal

Based on the output of the normality test in table 1 using a significant level in the Kolmogorov-Smirnov[a] test of 5%, the ρ-value on the dry film CR is 0.017 (ρ <0.05) and the ρ-value on the Inkjet film is 0,000 (ρ <0.05). Data from the two types of films show the distribution of data that is not normally distributed, so that it is continued with the Wilcoxon test. With the Wilcoxon statistical test, the results shown in Tables 2 and 3 are obtained

Table 2. Statistic Test of Wilcoxon Output 1

	Inkjet Film – Dry Film CR			
	Negative Ranks	**Positive Ranks**	**Ties**	**Total**
N	63[a]	0[b]	0[c]	63
Mean ranks	32,00	0,00		

Table 3. Statistic Test of Wilcoxon Output 2

Variable	**Sig. (2-tailed)**	
Density Value on Dry Film - Density Value on Ink-jet Film	0,000 (ρ < 0,05)	H0 is Rejected and Ha is Accepted

Based on the two Wilcoxon statistical test outputs result in tables 2 and 3 can be said that in the first output the negative rank 63 value is higher than the positive rank value 0, which means the density value on the ink-jet film is lower than the density value on the dry film CR. In table 3 as a result of the second output from the statistical tests conducted show that the significant value (Asymp. Sig. 2-tailed) is 0,000 which is not greater than 0.05 (ρ <0.05) then based on that value it can be stated that H0 is rejected and Ha is accepted which means there is a difference in density values between ink-jet film and dry film CR.

DISCUSSION

Radiology unit is the one means to support the enforcement of diagnosis by a film media that can record an object after X-rays pass through, resulting in a form of a picture of the object through the process [1]. Radiography films has a wide range of characteristics that can be seen from

the film composition, shape, color, size and level of sensitivity in interacting with the x-ray. Currently, Indonesia has a wide range of modalities in the field of health, especially in the radiology unit which makes everything easier and faster to do, one of the technologies in the radiology is Computed Radiography (CR) which is a systems that integrated with one another to the other to make everything more easier especially to make a radiographic images.

Computed Radiography (CR) is slowly replacing the manual systems that use chemical liquids in the form of developers and fixers which in practice are not as efficient as computed radiography (CR) in terms of time and influence on the environment. The Output can be displayed and generated on the computer monitor or in the form of radiographic film using dry film. Some hospitals in Indonesia have also implemented the use of ink-jet film as an output media that can show the results of the interaction between X-rays and objects by printing methods use inks from conventional printers that are often used to print HVS paper, this is done to reduce costs. Hopefully that the results obtained will still have a good quality to support the establishment of a diagnosis of the patient.

The Wilcoxon test shows a value (Asymp.Sig. 2-tailed) of 0,000 (ρ <0.05) which means there are differences in the ink-jet film and dry film. This can occur because in the process of printing the two films using different methods and materials, dry film which is part of the laser film is a single emulsion film coated by silver halide crystals that are sensitive to the red light emitted by the laser. The laser imaging film layer consists of supercoat, emulsion, substratum, base film, anti-curl backing, anti-halation layer [11].

While an ink-jet printer is the one of an electronic device that is connected to a computer to print data, by spraying inks on a media. Ink-jet printers use dor or demand technology by spraying tiny dots of ink on a paper through a small nozzle or pipe hole [12].

Dry Film CR which has a density value that is more optimal when compared to inkjet films. The rapid development of technological advances, especially in the field of radiology, made most hospitals print radiographic output mostly using laser printers because they were considered the most superior at this time. Laser printer performance is superior to paper printers [13]. This is also reinforced by the results of research that shows the average value of maximum dry film density is higher when compared to ink-jet films. High density greatly influences the quality of a radiograph result which is related to the detail of the radiograph result itself [1].

This is also shown by the type of dry film CR which can visually show the results of the picture with a darker level that is more concentrated when compared with Ink-jet Film. However, the use of dry film along with CR laser printers requires quite high costs for equipment and maintenance [8]. The use of inkjet printers to print radiographic output can be used to reduce costs to be cheaper [9]. The cost of printing radiographs using ink-jet films using paper can reduce costs tremendously, assuming a tenth is cheaper than using dry film lasers, so the economic benefits of using ink-jet film will be quite large [14].

In radiographic wrist joint photographs the use of paper using an ink-jet printer can be a reliable alternative as a substitute for dry film laser [15]. The quality of the chest radiograph using an inkjet film can diagnose well, where the results of research using ink-jet film and laser film can both diagnose the chest radiograph using a phantom of the chest with a number that is simulated in the mediastinal of the right lung fund [14].

CONCLUSION

From the research that has been done, it can be concluded that there are differences in density values between the two types of films studied, namely dry film computed radiography and ink-jet film. From the two types of film, dry film CR which has a higher density value and more optimal when compared to ink-jet film.

Recommendation

It is necessary to conduct research and further study of the type of ink-jet film to determine the strengths of the film given the hospital's need for adequate supporting media at an affordable price.

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