



COMPARISON OF COMPUTED RADIOGRAPHY(CR) AND DIGITAL RADIOGRAPHY(DR) IMAGE QUALITY TOWARD LOW-CONTRAST AND HIGH-CONTRAST OBJECT

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Abstract—Testing of CR and DR radiograph capabilities has been performed to produce images of low-contrast and high-contrast objects. The image quality of the two modalities is compared to know the advantages and disadvantages of each modalities in producing images of low-contrast and high-contrast objects. The phantom used is made of acrylic in which there are 10 objects with different densities representing low-contrast and high-contrast objects. Phantom is exposed by using a voltage of 70 kV and a current-time variation of 1.6 mAs, 2 mAs, 4 mAs, 8 mAs, 16 mAs, and 31.5 mAs. The result is that CR contrast value is bigger than DR, but CR has a much larger noise than DR. The SNR and CNR values of the resulting DR image are greater than those of CR. The highest SNR in CR is obtained at a current-time of 4 mAs and at DR current-time of 8 mAs. The highest CNR values on CR are 16 mAs current-time for low-contrast objects and 31.5 mAs for high-contrast objects, whereas in DR current-time 8 mAs for all objects.

Keywords—Computed Radiography; Digital Radiography; low-contrast; high-contrast;

I. INTRODUCTION

In radiography the use of conventional films has begun to switch to digital systems [1]. Radiography with digital systems is preferred because it has many advantages such as the magnitude of detection efficiency, high dynamic range, contrast can be improved, and can be further processed one of them with computer-aided diagnosis (CAD) [2] [3]. Digital radiography that is widely used in digital diagnostics is Computed Radiography (CR) and Digital Radiography (DR). In Digital Radiographic Quality Control (QC) devices in a simple low-contrast test can be done using stepwedge [4].

In addition to using stepwedge in low contrast tests, the use of Contrast Detail Phantom (CDP) is also widely performed. CDP used for example is TOR CDR phantom and CDRAD phantom. TOR Phantom CDR can be used for low or high contrast test. TOR CDR is a perspex plate and metal in it [5].

While the phantom CDRAD is generally made of acrylic and there are holes that contain air with varying sizes. In the test using the phantom CDRAD it was found that at certain doses the DR was far superior in low contrast detection than CR [6] [7]. CDP is generally less representative of the state of tissue in humans, other than that the variation is only a variation of thickness alone [8]. Acrylic material has characteristics similar to human body tissue. Acrylic has a density of 1.18 g / cm³ which is close to the average density of the human body [9]. Therefore the use of acrylic as a phantom material is often used. In this study phantom acrylic is inserted materials with varying densities that represent low and high contrast objects. Therefore, with this phantom CR and DR can be known ability in producing image in representing object with high or low contrast

II. METHOD

The data were collected at Diponegoro National Hospital. The specifications of each modality are Philips Duo-Diagnost DR and Kodak Carestream Directview CR. Both modalities were treated with the same conditions in phantom exposure with a 70 kV voltage value and a current-time variation of 1.6 mAs, 2 mAs, 4 mAs, 8 mAs, 16 mAs, and 31.5 mAs. The selected voltage corresponds to the voltage values that become the standard of X-ray modality Quality Control (QC) according to the IAEA (International Atomic Energy Agency).

Phantom used in this research is phantom made of acrylic or polymethylmethacrylate (PMMA) with dimensions of 10x15x2 cm³. In the phantom there are various objects with varying densities that represent low-contrast and high-contrast objects. The object inside the acrylic with tube shape is 1 cm in diameter and 1 cm high. For the phantom shape and the type of material used can be seen in Fig. 1. Objects 1-5 for low-contrast objects, whereas 6-10 for high-contrast objects.

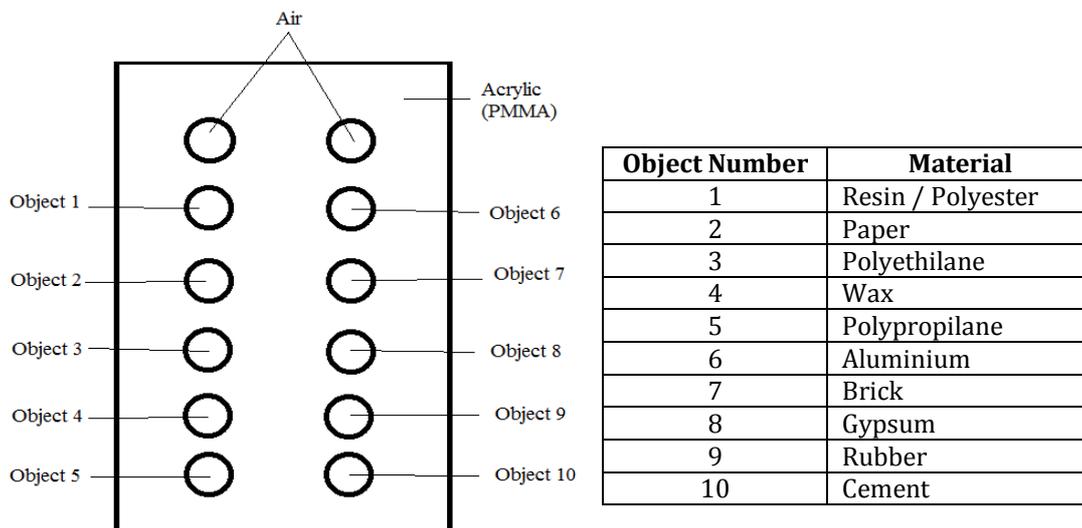


Fig. 1 Acrylic phantom with inserted material.

Phantom is exposed using either CR or DR with the same time flow variation. The resulting image is compared to the contrast value, Signal-to-Noise Ratio (SNR) and Contrast-to-Noise Ratio (CNR) for high-contrast objects and low-contrast objects.

III. RESULT AND DISCUSSION

A. Analysis of Contrast Value

Calculation of contrast values obtained from the image generated by CR and DR. Image of CR and DR in DICOM format with 12 bit resolution in accordance with medical requirements standards. With a computer image device is analyzed from the gray scale value generated by each object against the background of the image.

Qualitatively the change in current-time values affects the image contrast value. The greater the current-time value the resulting image darkens as the greater the current-time the greater the dose is received. The magnitude of the dose effect on the X-ray beam received object. the more X-raybeam the object receives the more x-ray beam are absorbed or passed on. This applies to both modalities. The resulting image of both modalities can be seen in Fig. 2. The result of the image analysis shows that CR has higher contrast value than DR. This applies to both low and high-contrast objects. For both low and high contrast objects, the CR and DR contrast values are greater with increasing current-time values except for DR at 31.5 mAs current-time values. At 31.5 mAs current-value value the contrast on the DR actually decreases even for low-contrast objects becomes invisible. This is due to the greater the current-time, the more electrons that will pound the anode and the resulting X-ray the greater the number. This causes the object's contrast value to decrease.

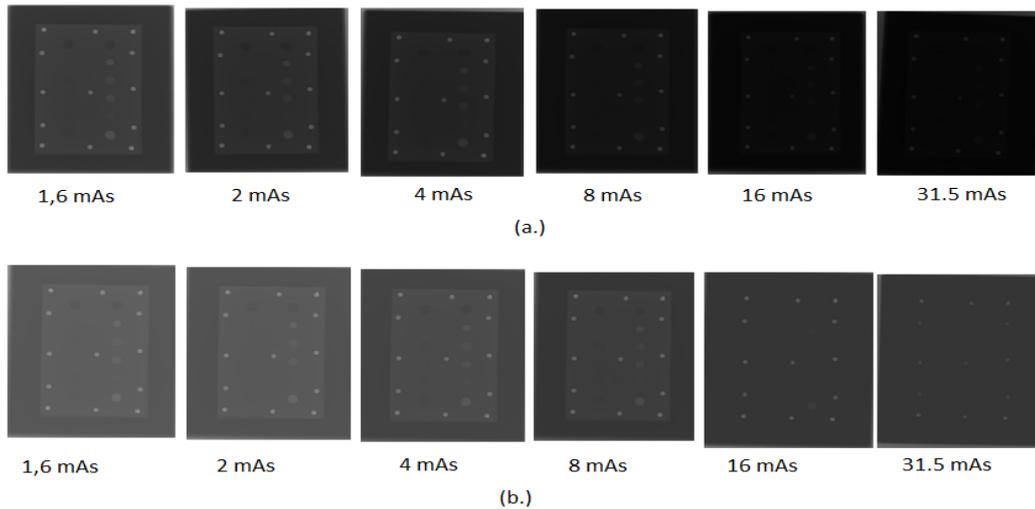


Fig. 2 Image (a.) CR and (b.) DR at 70 kV voltage.

For the increase in contrast values in both modalities, CR is significantly more significant than DR. However CR has a noise value greater than the DR and it will also affect the quality of the resulting image.

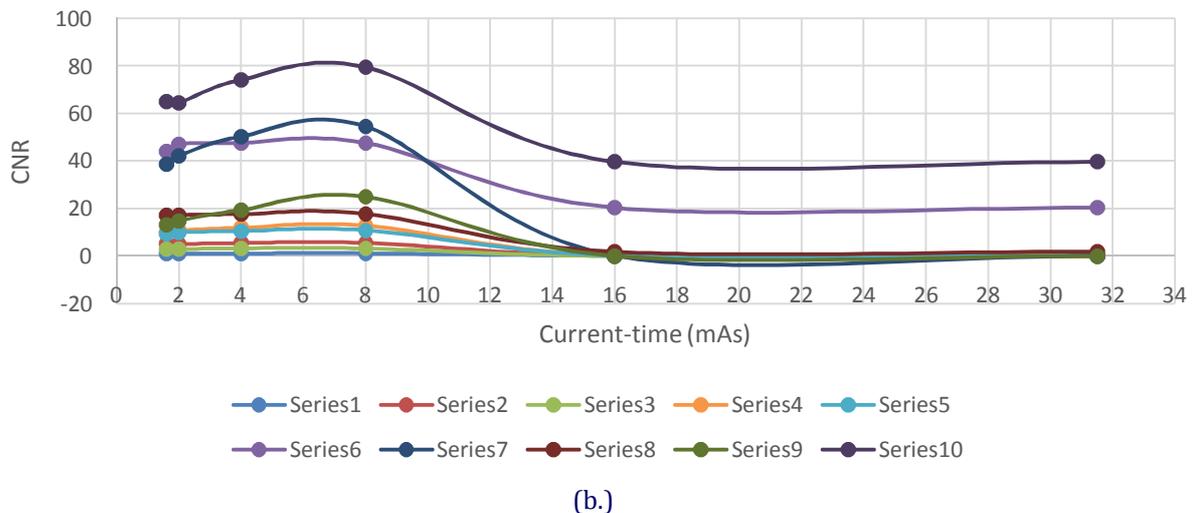
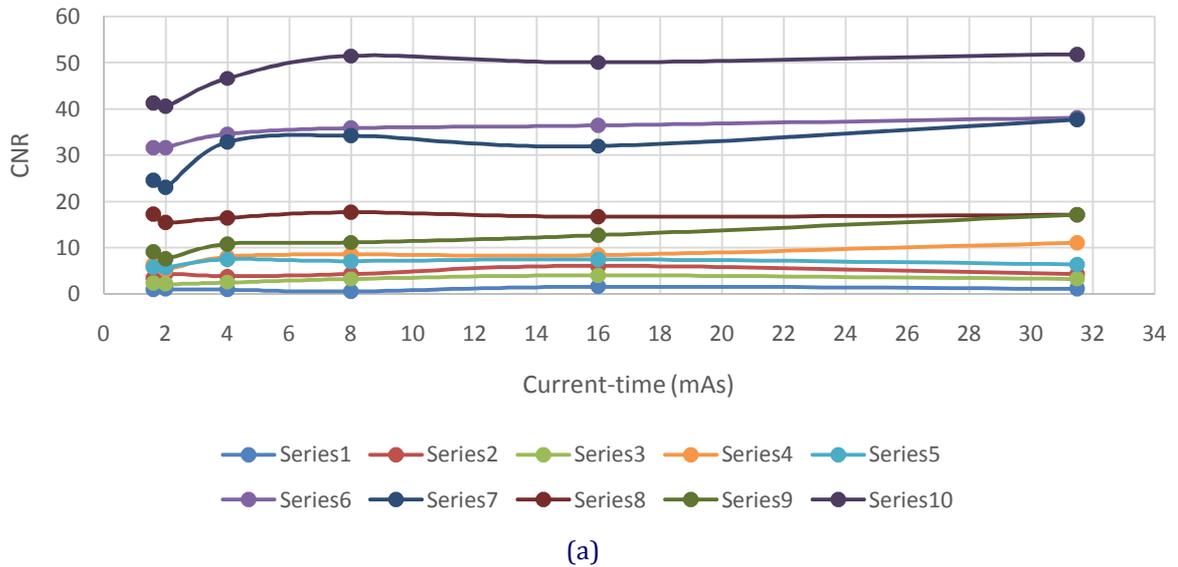


Fig. 3 Result of CNR analysis toward 10 object (which shown by series) with current-time variation (a.) CR dan (b.) DR

B. Analysis of SNR and CNR

SNR (Signal-to-Noise Ratio) and CNR (Contrast-to-Noise Ratio) are parameters in determining the quality of an image. The bigger the SNR and CNR value the better the image quality. SNR and CNR are influenced by the value of contrast and noise generated. At CR the highest SNR value obtained is when the current-time value of 4 mAs and DR has the highest SNR value at the time-current value of 8 mAs. For the highest SNR value in DR is much greater than the highest SNR value in CR.

The CNR value of the image is shown in Fig. 3. In the graph shows that at CR the CNR value on the low contrast object tends to be of high value when the time-current is 16 mAs while for the high contrast object at the current value of 31.5 mAs. In DR is obtained the largest CNR value at 8 mAs current-time value for low-contrast objects as well as high-contrast objects. For CNR DR value is far superior compared to CR.

C. Image Quality Comparison

Image processing has been done from phantom exposure using CR and DR modality. Phantom consists of 10 objects that have different densities and grouped into 2 categories namely 5 low contrast objects and 5 high contrast objects. Low-contrast objects have densities close to the value of acrylic density, whereas high contrast objects have densities that are quite large in magnitude than acrylics. From the resulting image, the CR image visually appears darker than the DR. From the analysis obtained the contrast value on CR almost all objects tend to rise when the value of current-time is getting bigger. Significant increases occur between 16 mAs and 31.5 mAs current-time values. This applies to high contrast obstruction as well as low contrast. In DR the contrast value increases from the change of time current from 1.6 mAs to 8 mAs. The change in value is not so significant. From the strong start of the time currents valued at 16 mAs to 31.5 mAs contrast in the value of the DR is decreasing. Even at a strong current time of 31.5 mAs, the low-contrast scores of low-contrast objects do not appear to differ from the background.

Although CR has a much higher contrast value than DR, CR has a larger noise value compared to DR. This is due to the 70 kV DR voltage having a higher level of Detective Quantum Efficiency (DQE) than CR [6]. It is known that when the use of 7kV CR voltage has a DQE efficiency of 30% [10] while the DQE efficiency on DR is more than twice that of CR by 66% [11]. Therefore the resulting SNR value will be affected. From the results obtained although the contrast of the larger CR was SNR value is actually smaller than the SNR value in DR. SNR in CR got its highest value at 4 mAs current-time where the lowest value is 381.622 in object 5 and highest is 472.528 at object 10, while at DR value highest SNR at time-current 8 mAs with lowest value 926.43 on object 5 and the highest value of 1166.013 on the object to 10. From that value is very much difference the value of SNR produced and DR much better than CR. In the CNR assessment obtained DR is still dominant higher than CR. In CR for low contrast object obtained the highest CNR value at time current 16 mAs with maximum value 8.529 at object 10 whereas for high contrast object at 31.5mAs current time with value 51.87 at object 10, whereas at DR got the highest CNR value at time-current 8 mAs with the highest value of 74.003 on object 10. From the CNR value it is seen that DR is still superior in the quality of its image compared with CR. Although DR is higher the SNR and CNR value of CR is still in the unreadable level of its image.

IV. CONCLUSION

From the results obtained data shows that DR has CNR and SNR values greater than CR. Although DR is lost in contrast but DR is superior in reduction of noise value generated. The DR has the same high and low contrast object readability capability, but is weak when the large current-time value. While the contrast value CR will be higher even though the current-time value is very large.

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