ISSN (Print) : 2337-9030 ISSN (Online) : 2685-2608
PILLAR OF PHYSICS
JURNAL BERKALA ILMIAH FISIKA
Vol. 18 (1), 2024, page. 50-55
DOI : 10.24036/17211171074

KILOVOLT VARIATION AND DIGITAL IMAGE CONTRAST: PHANTOM STUDY COMPARISON

Sagita Yudha[1*], Nerifa Dewilza[1], Oktavia Puspita Sari[1], Chairun Nisa[1], Vania[1]

[1] *Radiodiagnostic and Radiotherapy, Vocational Faculty, Baiturrahmah University, Jl. Raya ByPass Km 15 Aie Pacah Koto Tangah, Padang, 25176, Indonesia*

Corresponding author. Email:sagitayudha@atro.unbrah.ac.id

ABSTRACT

An exposure factor that is too high can result in radiography results that are too black (dark), and an exposure factor that is too low can result in results that are white (bright). Providing an inappropriate exposure factor can prevent the radiograph from providing the best information. When the exposure factor is set properly, radiographic contrast can be maximized, allowing different organs with varying densities to be clearly distinguished from one another in terms of blackness. This kind of research combines an experimental study with quantitative methods. The experimental approach can be understood as a research technique to compare treatments with one another in a controlled environment in order to compare kV fluctuations in the pelvic phantom and achieve the best possible picture quality (contrast). The data processed in the Image J application in the form of a histogram graph is strengthened by data processing using SPSS and the Friedman test. Based on the results of the analysis of the Friedman test, there is an influence, the results obtained at kV 70 show the highest mean rank of 4.57 and in the image J application it shows at kV 70 with graphic results on the histogram of contrast levels which are good, then the radiographic results of the comparison of variations in kV versus contrast in the optimal pelvic phantom are obtained, namely at kV 70.

Keywords : *Contrast Image; Dose radiation; Image J; Variation kV.*

I. INTRODUCTION

The Radiology Installation is one of the supporting installations in a hospital. One of the main tasks of the Radiology Installation is to produce images (pictures) and examination findings reports for diagnostic purposes. Radiographic examination of body anatomy can provide the most informative data, which can be easily determined by a radiologist, requiring good quality radiographic images. The quality of radiography greatly influences the accuracy of diagnosing a disease in the field of radiodiagnostics. An image with good radiography quality can give detailed information about the object or organ being studied. If the exposure factor is set incorrectly, the radiograph may not show the best information; if the exposure factor is set too high, the results may be too black (dark); if the exposure factor is set too low, the results may be too white (light) [1]

When creating radiographs, the exposure factor is an internal factor that regulates the quantity, quality, and duration of X-ray photons. These variables are time (s), tube current (mA), and electric voltage (kV). When the exposure factor is set properly, radiographic contrast can be maximized, allowing different organs with varying densities to be clearly distinguished from one another in terms of blackness. The penetrating power of the X-rays is determined by the tube voltage; the higher the kV employed, the larger the penetrating strength of the rays, and vice versa [2]. In order to create X-rays with an energy and intensity high enough to enter some organs, the tube current controls how many electrons will pass through the target. The amount of X-rays produced is determined by the duration of exposure, which is determined by time [3].

In order to create X-rays with an energy and intensity high enough to enter some organs, the tube current controls how many electrons will pass through the target. Time controls the exposure duration and, in turn, controls the number of X-rays generated [4]. Radiological imaging's capabilities have increased as a result of the switch from analog to digital radiography, but patients' radiation exposure has also increased. The dose and picture quality in radiology are directly impacted by radiographic procedures (kVp and mAs), among other considerations. With regard to radiological exams, this study concentrates on pediatric patients because of their longer life expectancy and higher radiosensitivity. Using the CDRAD contrast-detail phantom, the study sought to determine whether applied radiography procedures and image quality were correlated. According to the findings, there is a direct linear correlation between rising kVp and rising image quality[5].

Quality control refers to a routine program of equipment quality assurance that is implemented to ensure that the machinery is always in optimal working order and can generate the highest possible output. The most crucial element is the safety and quality of radiodiagnostic services since, if improperly managed, they can endanger patients, employees, and the surrounding area. For this reason, quality control must be performed on a regular basis. [6]

The quality of the radiographic pictures generated is one of the crucial quality standards in diagnosis. A disease's diagnosis is influenced by the radiography's quality. When using radiation sources, patients, radiation professionals, and the general public must all receive the lowest dose possible [7]. It is anticipated that radiological examination will produce high-quality radiograph results with the least amount of radiation exposure [4].

II. METHOD

This scientific article uses experimental and quantitative research methods. The experimental approach can be understood as a research technique to compare treatments with others in controlled settings in order to compare kV fluctuations in the pelvic phantom and achieve the best possible image quality (contrast) [8]. The main procedures are show figure 1.

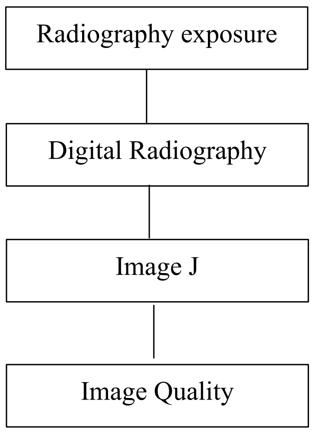

Figure 1. Research Procedure

Processing digital images with Image J The health sector has made extensive use of Image-J for digital image analysis. Using the Histogram feature of the picture-J application, one example of how this software is used is to assess the picture contrast quality of radiography images [9]. The steps or procedures undertaken in this research are as follows: Preparing research instruments such as Digital Radiography (DR) X-ray machines, Pelvis phantoms, and Image J Application. Next step, Conducting the creation of radiographs with 5 exposures of the same object on the pelvis phantom by varying different kV and keeping the mAs the same. Processing film using Digital Radiography (DR). Image processing with Digital Radiography must be controlled and done without image editing. The results of the phantom pelvis imaging are then transferred via DVD in DICOM data format. Then it is transferred to the ImageJ application to process the image quality data to determine the image quality value against contrast in the form of a histogram. The five results of the phantom pelvis radiographs with different kV variations and the same mAs were presented to respondents to assess the visualization quality of the radiographic images using the prepared questionnaire. After the questionnaire data is obtained, it is processed using the SPSS program with the Friedman Test. After obtaining the results from this respondent, it will serve as a supporting reference in the data processing within the Image J application. After processing the data, a conclusion was reached on which radiograph is better between creating a radiograph on a pelvis phantom that varies kV with the same mAs against the contrast in the optimal pelvis phantom image.

The SPSS software analysis is a contributing element to the visual reinforcement of the data. The Image J application, an image assessment system based on a left-to-right histogram, is then used to continue processing the data. Black (dark) is represented by the graph's left end, gray by the middle end, and white (light) by the right end [9].

III. RESULTS AND DISCUSSION

In this study, a pelvic examination was performed five times at RSUP Dr. M Djamil Padang using a phantom pelvis as a subject in place of a patient who had been asked for permission to borrow it from the Baiturrahmah University laboratory. The exposure variations included kV 61.5 kV, 64 kV, 66 kV, 68 kV, and 70 kV with mAs 12.5. The phantom pelvis radiograph results were acquired[10]. Next, the J application was used to examine the image quality in histogram form while processing the radiograph image data created in DICOM format in 8-bit file type [11].

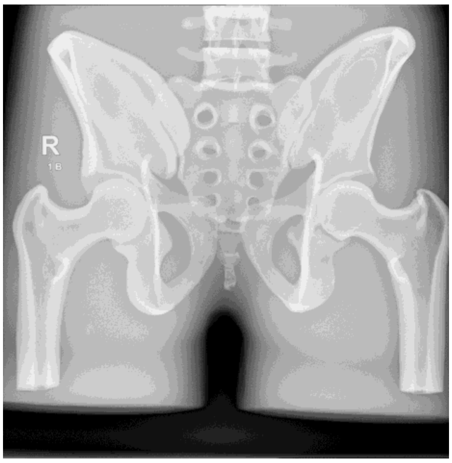

Figure 2. Radiograph (1B) of sample 1 with kV 61.5

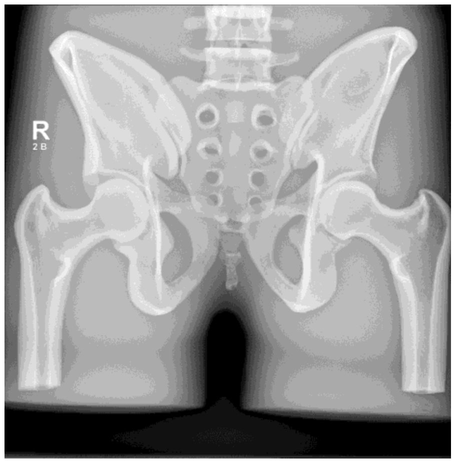

Figure 3. Radiograph (2B) of sample 2 with kV 64

An image's brightness and contrast levels can be ascertained using the data in the histogram. The width of the histogram shows the determination itself. The image exhibits an excessively bright (overexposed) or dark (underexposed) contrast if the histogram's width is too small. In the meantime, an even breadth of the histogram indicates that every pixel intensity value has a full and even gray degree, indicating that the image is of high quality. The apex of the histogram shows the pixel intensity it self.

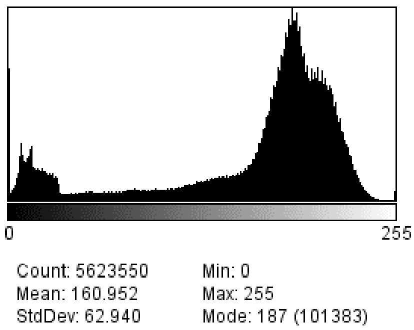

Figure 4. Histogram 1 (1b) kV 61,5

With a standard deviation value of 62,940, the image with strong contrast or excessive brightness is included in the overexposed category. This is evident in Figure 4. Histogram 1 (1b) kV 61.5, where the histogram graph is higher or has a high gray level.

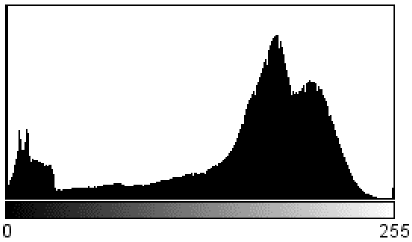

Figure 5. Histogram 2 (2b) kV 64

You can see that the histogram graph in Figure 5 Histogram 2 (2b) kV 64 tends to be high, or the gray level indicates that the image is excessively bright or has a high contrast and falls into the overexposed group since it tends to be toward the right with a standard deviation value of 63,633.

The image's pixel values are displayed on the histogram graph's Y (vertical) axis, while the image's grayscale values are displayed on the X (horizontal) axis. An image's brightness or contrast can be assessed by examining its grayscale; specifically, if the histogram gathers at a high gray level (which tends to approach the value 255), the image is too bright, and if it collects at a low gray level (which tends to approach 0), the image is too dark.

An image's brightness and contrast levels can be ascertained using the data in the histogram. The width of the histogram shows the determination itself. The image exhibits an excessively bright (overexposed) or dark (underexposed) contrast if the histogram's width is too small. In the meantime, an even breadth of the histogram indicates that every pixel intensity value has a full and even gray degree, indicating that the image is of high quality. The apex of the histogram shows the pixel intensity itself.

In addition to examining the image histogram, one can compute the variance and standard deviation to determine an image's contrast. Standard deviation is the value on the gray axis that indicates the distance between each pixel and the average gray degree value, whereas variance is a value that measures the distribution of histogram values around the average gray degree value. The visual contrast value increases with increasing variance, indicating a higher standard deviation value.

The five histogram graphs above are as follows: Histogram 1 has a kV of 61.5 and a standard deviation value of 62,940; Histogram 2 has a kV of 64 and a standar Deviation value of 63,633; Histogram 3 has a kV of 66 and a standard deviation value of 63,758; Histogram 4 has a kV of 68 and a standard deviation value of 63,429; and Histogram 5 has a kV of 70 and a standard deviation value of 61,984. With a standard deviation value of 47.38, the normal histogram graph value is more likely to gather uniformly in the middle, and histogram 5, with a standard deviation value of 61.984, is closest to the limit value for a good or normal image. The 5 (5b) kV 70 histogram is the superior histogram graph, according to the analysis of the generated histogram, since a wide gray value distribution without any dominant gray value indicates strong contrast quality in an image.

Discussion

Histogram 1 has a kV of 61.5 and a standar Deviation value of 62,940. Histogram 2 has a kV of 64 and a standar Deviation value of 63,633. Histogram 3 has a kV of 66 and a standar Deviation value of 63,758. Histogram 4 has a kV of 68 and a standar Deviation value of 63,429, and Histogram 5 has a kV of 70. standar Deviation is 61,984 in value. Histogram 5 is closest to the limit value for a good or normal image, with a standar Deviation value of 61.984. The normal histogram graph value tends to gather in the middle and evenly, with a standar Deviation value of 47.38. Increasing of mAs leads to the improvement of DQE, spatial resolution, and contrast as well as decline of noise. Unfortunately, on the other hand, it drastically increased patient radiation dose. The DR units had higher spatial resolution and contrast as well as lower noise than the CR units[12]. The physical parameters of the image quality have important role in assessment of image quality performance of radiography units [13].

An image's brightness and contrast levels can be ascertained using the data in the histogram. The width of the histogram shows the determination itself. The image exhibits an excessively bright (overexposed) or dark (underexposed) contrast if the histogram's width is too small [14]. Conversely, an equal histogram width indicates that each pixel intensity value has a full range of gray levels, indicating high-quality image data. The apex of the histogram displays the pixel intensity itself.

According to the Friedman test of kV fluctuations, the mean rank at KV 61.5 is 1.57, the mean rank at KV 64 is 2.30, the mean rank at KV 66 is 2.87, the mean rank at KV 68 is 3.70, and the mean rank at KV 70 is 4.57. In terms of SPSS data processing, the test results at kV 70 exhibit the greatest outcomes or the highest value for identifying the radiograph with the ideal kV changes in contrast in the pelvic phantom image. For several variations in exposure factors, there is no difference in quality both in terms of sharpness and sharpness. useful that the use of exposure factors is chosen as minimal so that the exposure or dose received is smaller[15]

According to the resulting histogram analysis, the 5 (5b) kV 70 histogram is the best histogram graph because a wide gray value without any one gray value predominating indicates strong contrast in an image. The 5 (5b) kV 70 histogram is the superior histogram graph, according to the analysis of the generated histogram, since a wide gray value distribution without any dominant gray value indicates strong contrast quality in an image.

An image with a wide range of gray values and no one value predominating is considered to have good contrast quality. An intensity value or color level that is near to 0-80 without any dominating gray or black values is a good image histogram distribution. A good image is one that exhibits a distinct range of gray values or degrees of gray without any dominating gray values[16]

IV. CONCLUSION

The following findings can be made in light of the research that was done, including the comparison of kV fluctuations to contrast in pelvic phantom pictures utilizing the iamge j application: picture's histogram graph is gathered in the middle, the contrast in the pelvic phantom image obtained with the image j application at kV 70 with mAs 12.5 70 is good or good image presentation. Compared to other kV variations, the pelvic phantom picture exhibits good contrast when using the 70 kV variation with 12.5 mAs, according to the research findings.

ACKNOWLEDGMENT

Our gratitude goes out to the M Djamil Padang Hospital, Baiturrahmah University, which provided funding for this study, as well as other radiographers who provided assistance.

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