

## Effect of exposure factors on radiographic image quality in the use of abdominal phantom with ap projection

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### ABSTRACT

Radiographic examination of the anatomy of the body can provide the maximum possible information that is easily determined by the Radiologist, if the quality of the radiographic image is good. To be able to produce radiographs that provide maximum information, optimal radiography is needed. In radiographic examinations, factors are needed that can affect the quality of photos in order to get better results. These factors include the exposure factor. The exposure factor consists of voltage (Kv), tube current (mA) and time (s). The purpose of the study was to determine the exposure factor on the quality of radiographic images on the use of abdominal phantoms with AP projections. The method used was experimental research. In some variations of the expulsion factor, there is no difference in quality both in terms of contrast and sharpness. The images produced from each variation are good and informative, so it can be assumed that the use of the exposure factor is chosen the most minimal so that the exposure or dose received is smaller. Image quality analysis should be made with a wider range of Kv and mAs, and using phantom objects other than abdominal phantoms.

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## INTRODUCTION

In the Medical field, the use of X-rays for diagnostic imaging has been used for more than a century. The use of X-rays in the medical field, serves to provide information from the human body, so that doctors can take action correctly according to the information obtained (Haleem & Javaid, 2019; Sari & Fransiska, 2018; Sinaga, 2006).

Radiographic examination of the anatomy of the body can provide as much information as possible which is easily determined by a radiologist, it requires good radiographic image quality. The quality of radiography is very influential in determining the accuracy of the diagnosis of a disease in the field of radiodiagnostics (Al Shahrani, 2022; Azam & Dhahryan, 2009; Gatt et al., 2022; Nehru, 2017).

To be able to produce radiographs that provide as much information as possible, optimal radiographs are needed. In radiographic examination, it takes factors that can affect the quality of the photos in order to get good results. These factors include exposure factors. The exposure factor consists of electric voltage (kV), tube current (mA) and time (s). The electric voltage (kV) is a unit of potential difference that is provided between the cathode and anode in the Roentgen tube. kV or electric voltage will determine the quality of x-rays and the penetrating power of x-rays, the higher the amount of voltage used, the greater the penetrating power (Bushong, 2020). In determining the electrical voltage, it is better to use the optimal voltage that is able to produce clear object details. The things that affect the tube voltage are the type of shooting, the thickness of the object, the shooting distance, the equipment used (Girsang, 2022; Sari & Fransiska, 2018).

One of the efforts in image quality assurance is the Quality Control (QC) procedure related to the monitoring and maintenance of radiodiagnostic equipment. All of these tests are regulated in the RI Ministry of Health No. 1250/MENKES/SK/XII/2009 Concerning Guidelines for Quality Control of Radiodiagnostic Equipment.

Quality Control is an equipment quality assurance program that is carried out periodically with the aim that the equipment is always in good condition to produce maximum output. The quality and safety of radiodiagnostic services is the most important factor because it can pose a danger to staff, patients and the surrounding environment if it is not managed properly, so quality control is very necessary on a regular basis (Anggara, 2020). One of the Quality Controls that is important in the diagnosis is the quality of the radiographic image produced.

The quality of radiography is a determinant of the diagnosis of a disease. Utilization of radiation sources requires receiving the lowest possible dose for patients, radiation workers and the public. Radiological examination is expected to be able to obtain quality radiograph results with small radiation exposure.

The quality of the radiograph is the ability of the radiograph to provide clear information about the object or organ to be examined. The quality of a radiograph is determined by several components, including: density, contrast, sharpness and detail. The exposure factor is a factor that influences and determines the quality and quantity of the X-ray irradiation required in the manufacture of radiographic images. The exposure factor consists of tube voltage (kV), tube current (mA), and exposure time (ms) (Pradana, 2011; Rilianti & Oktarlina, 2017).

Based on the background above, the researcher is interested in adopting it as research and studying more deeply about "The Influence of Exposure Factors on Radiographic Image Quality in the Use of Phantom Abdomen with AP Projection". The goal to be achieved in this study is to determine the effect of exposure factors on the quality of radiographic images in the use of phantom abdomen with AP projection. The implication of the study is that by knowing the effect of exposure factors on radiographic image quality, image quality optimization can make appropriate adjustments in setting exposure parameters when performing abdominal radiographs with AP projections. This will help improve radiographic image quality and ensure optimal diagnostic information.

## RESEARCH METHOD

This research is an experimental research (Anjani et al., 2022) namely research directed to determine the effect of exposure factors on the quality of radiographic images on the use of Abdominal phantom with AP projection (Davies et al., 2020). With the independent variables using exposure factors kV 75 and kV 80 and mAs 20 and 25. As well as the dependent variable, namely image quality. The object used in this study is the Phantom Abdomen. The purpose of using the Abdomen Phantom is as a substitute for the patient's abdomen and to avoid the radiation dose given during the study. Data analysis uses a visual grading system by applying an image quality assessment based on eye observation. Then choose the best radiograph results. The analysis was

carried out based on the parameters of image visualization and histogram of gray degrees. Analysis was performed on the contrast (Contrast) and sharpness of the image (Sharpness).

## RESULTS AND DISCUSSIONS

### 3.1. Research result

#### Research Description

This research was conducted to determine the effect and optimum value of the exposure factor of radiographic images using histogram indicators to see the degree of gray of a radiographic image. The results of the research are presented in the form of radiographic images of the phantom abdomen at the Laboratory of Diploma III in X-Ray Engineering, Widya Husada University, Semarang, which was conducted in August 2016. The exposure was carried out with variations in tube voltage and current using an X-ray mobile aircraft with the Toshiba Rotanode E7252X aircraft brand.


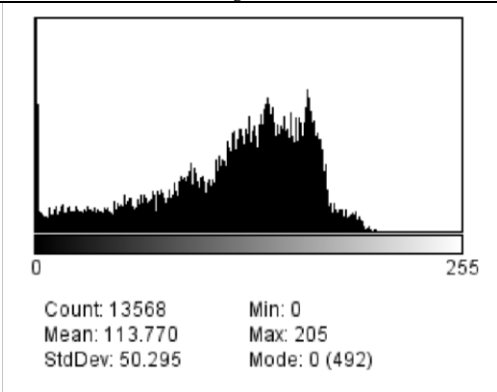
#### Exposure Factor Description

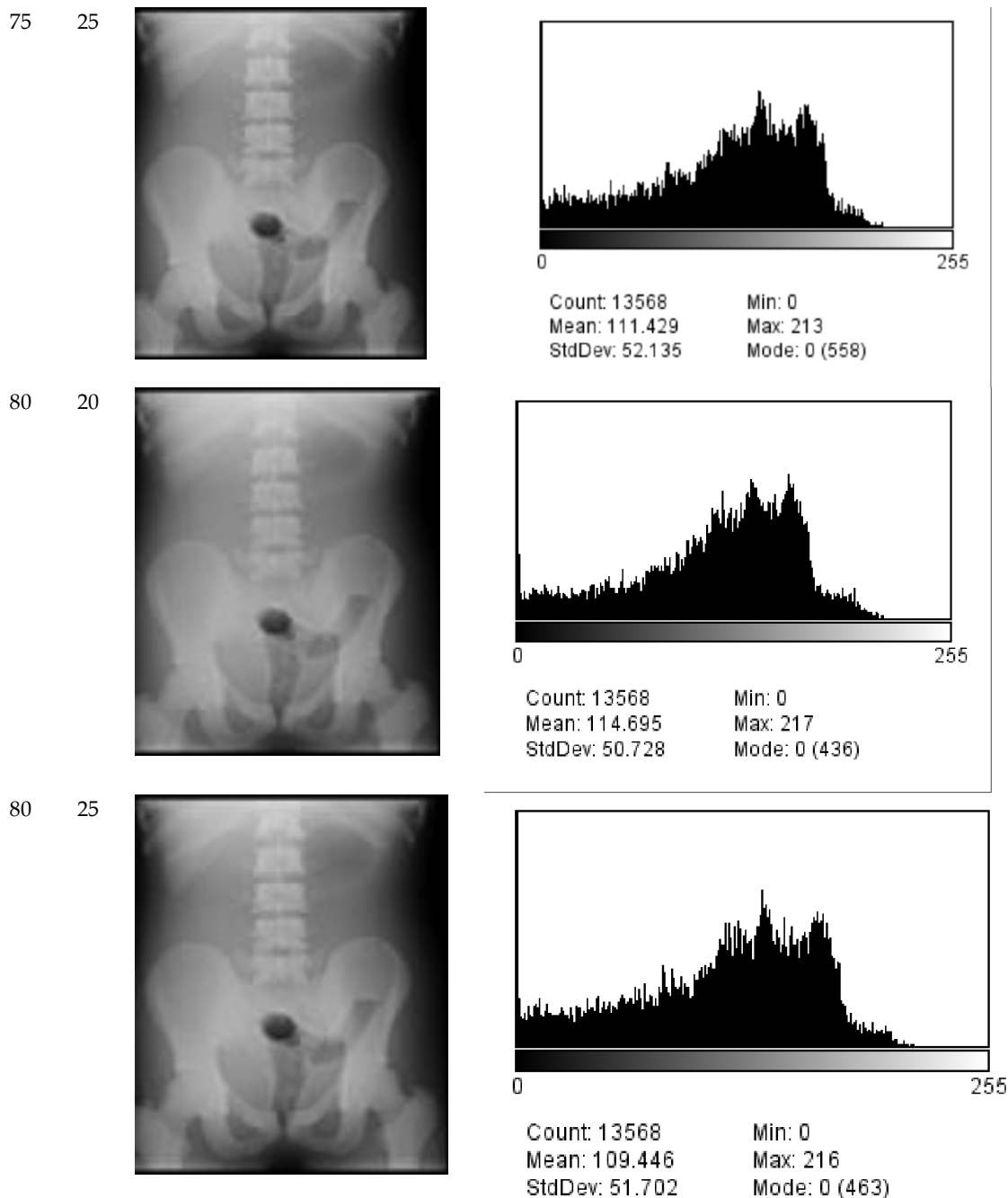
In this study, influence the exposure factor on the quality of radiographic images in the use of a phantom abdomen with AP projection is to evaluate the resulting image. The variation given for each voltage and current is done to limit the number of doses received with the existing image quality. For this reason, it is necessary to have variations of kV: 75, mAs: 20 and 25 and kV: 80, mAs: 20 and 25 on the AP Abdomen projection. Then the resulting image results are measured based on the image visualization parameters and the histogram of gray degrees. Analysis was carried out on contrast and sharpness of the image using a visual grading system by applying an image quality assessment based on eye observation. Then choose the best radiograph results. In the gray level histogram analysis, information will be obtained about the intensity distribution of the gray degree of the image based on the gray level distribution using the Java Image-J Basics version 1.38 software platform.

#### Effect of Exposure Factor on Radiographic Image Quality in the Use of Phantom Abdomen with AP Projection

The exposure factor is the internal factor that controls the characteristics of X-ray photons in terms of quantity (quantity) and (quality) and duration in making radiographs. In order to determine the influence of the exposure factor on image quality, it is necessary to vary the value of the tube voltage (kV) and the constant current value (mAs). Abdominal X-rays taken with variations kV : 75, mAs : 20 and 25 and kV : 80, mAs : 20 and 25 on the AP Abdomen projection. The value of the Exposure Factor condition is the examination condition for the AP abdomen (the beam is directed from front to back).

**Table1.** Voltage Variation on AP Abdomen Radiographic Image Results

kV	mAs	Radiography Image	histogram
75	20		 Count: 13568      Min: 0 Mean: 113.770      Max: 205 StdDev: 50.295      Mode: 0 (492)



Based on table 1 it can be explained that image quality analysis is carried out based on image visualization parameters which include image contrast and sharpness as well as analysis of the gray degree histogram to obtain information about the intensity distribution of the gray degree of the image based on the gray level distribution using the Java Image-J platform software with image size  $106 \times 128$  pixels and 8-bit resolution.

### **The exposure factor setting is capable of displaying the best image quality on Abdomen radiographic examination with AP projection.**

In several variations of the exposure factor, there was no difference in quality either in terms of contrast or sharpness. The resulting image of each variation is good and informative. So it can be assumed that the use of the exposure factor is chosen as minimal as possible so that the exposure or dose received is smaller.

### **3.2. Research Discussion**

A histogram is a graph that depicts the distribution of pixel intensity values i.e. the brightness and contrast of an image. The peak of the histogram shows the prominent pixel intensity, the width of the peak shows the contrast range of the image. This is in accordance with research by (Sriwahyuni, 2017) which explains Histogram is a graph used to describe the distribution of pixel intensity in an image. Usually, the horizontal axis on the histogram represents the pixel intensity range, while the vertical axis shows the number of pixels in the image that have a certain intensity. Contrast in an image refers to the difference between the intensity of light and dark pixels. The contrast range of an image can be seen through the width of the peaks on the histogram. If the histogram has narrow peaks, it indicates a small contrast range, whereas if the histogram peaks are wider, it indicates a larger contrast range (dan Pron, 2017; Zelviani, 2017).

Based on the histogram graph, it can be seen that the image is dark or bright, if the dominant histogram graph occupies the minimum area then the image is a dark image but if the dominant histogram graph occupies the maximum area then the image is a bright image. A good image is if the histogram graph fills the gray scale area completely with an even distribution at each pixel intensity, this is supported by research (Gonydjaja, 2023). Table 4.1 shows the histogram graph for each voltage variation where all images produced have histogram graphs that are not evenly distributed in each intensity. The intensity of the pixels is not distributed so that the radiographic image produced is still an imperfect image category. Based on the histogram analysis, the tube voltage used should use the minimum voltage and current of 75 kV and 20 mAs because the histogram graph produced on the radiograph image is not much different from other variations of the exposure factor and the radiation exposure received by the patient will be less. This is in accordance with research by (Anggara, 2020; Bushong, 2020) which shows that in radiography, the voltage and current used in the exposure technique can affect the image results and the radiation dose received by the patient. Histograms are used to analyze the intensity distribution of pixels in radiographic images. Based on your statement, it is said that using the minimum voltage and current of 75 kV and 20 mAs will produce histograms that are not significantly different from other variations of the exposure factor. Other studies (ARYANI, 2022; Jang et al., 2018; Rusyadi et al., 2021) mentioned that decisions about exposure parameters such as voltage and current should be based on broader considerations, including diagnostic needs, the type of disease or condition being observed, and the anatomical characteristics of the patient. These decisions should be made by an experienced radiographer or radiologist based on their knowledge of the radiographic technique, the clinical setting, and the specific reason for the examination.

Based on eye observation or visual grading, the image quality produced by all variations of either kV 75, mAs 20; kV 75, mAs 25; kV 80, mAs 20 and kV 80, mAs 25 has no significant difference, this matter is supported in research (Yudha et al., 2023) which explains image quality evaluation usually involves objective analysis using tools such as noise, contrast, and resolution measurements. The use of this objective measurement method can provide a more accurate assessment of the differences in image quality caused by variations in exposure parameters (Ramdhan, 2016). The image is capable of producing good contrast and sharpness. The overall image quality is also good and is able to show a clear anatomical picture. This is reinforced in research by (Ayu, 2018; YANDI, 2021) which explains that the selection of exposure factors in abdominal examinations with AP projections must consider several factors, including diagnostic needs, anatomical characteristics of the patient, and the radiation dose received by the patient. The

general principle in radiography is to use the smallest possible radiation dose, according to the required diagnostic needs (Dewilza et al., 2023; Gatt et al., 2022). So that for the selection of the exposure factor itself in the abdominal examination with AP projection can use the lowest voltage and current thus it is considered to be able to reduce the radiation dose received by the patient.

## CONCLUSION

The exposure factor is an internal factor that controls the characteristics of X-ray photons in terms of quantity and quality as well as the duration of making radiographs. To determine the effect of the exposure factor on image quality, it is necessary to vary the tube voltage value (kV) and the fixed current value (mAs). In some variations of the exposure factor, there is no difference in quality both in terms of contrast and sharpness. The images produced from each variation are good and informative. The contribution of the research is in the results of the study which show that the use of the exposure factor is chosen the most minimal so that the exposure or dose received is smaller. The implication of the research on image quality is that in several variations of the exposure factor, there is no difference in quality both in terms of contrast and sharpness so that it can be optimized to achieve good image quality. Optimize the exposure settings to achieve good image quality with the appropriate radiation dose. The limitation of the current study is to use an exposure factor of kV 75 and kV 80 and mAs 20 and 25, so the suggestion for further research is that the image quality analysis should be made with a more diverse kV and mAs, and use phantom objects other than abdominal phantoms.

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