Differences of Radiation Dose and Image Contrast on Anode Heel Effect Application with Thoracal Examination with Cathode Location in Proximal and Distal

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Abstract. On radiographic examination of the vertebrae, the difference in the thickness of the thoracic vertebrae causes differences in the intensity of radiation reaching the detector so that the image quality and the dose received by the patient is different in the superior and inferior parts. The difference in radiation intensity can be reduced by using the heel effect anode technique. Anode Heel Effect is the intensity of radiation emitted from the cathode end of the x-ray tube is greater than that emitted at the anode end. The arrangement of the anode and cathode location is rarely considered so that the anode is more often in the inferior part resulting in a low density radiograph of the inferior part. In addition to affecting the image, of course, the anode hell effect affects the radiation dose produced because of the different density intensities. The research design is descriptive research with quantitative data types. The location of data collection was carried out at the Radiology Laboratory of the University of 'Aisyiyah Yogyakarta. In this study, the whole body anthropomorphic panthom was used. The results of measurements of radiation dose and contrast with 70 kV and 10.5 mAs settings, obtained a higher dose and contrast value on thoracolumbar radiographic examination with the location of the cathode with an average dose rate of 55.93 µGy/s whereas if the cathode is in the distal the average radiation dose rate is 49.66 µGy/s. This is due to the anatomical shape of the thoracolumbar itself which is larger in the distal part than proximal so that the radiation intensity that reaches the detector is greater.

Keywords: anode heel effect · thoracolumbar

1 Introduction

He spine functions to straighten the body and maintain balance. The vertebrae are also responsible for supporting the head and hands, as well as being the attachment site for muscles, ribs and several other organs. There is some curvature of the spine. The

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curvature serves to support weight and allows the body to perform various movements and positions, such as standing, sitting, and running. The spinal column is composed of 33 bones with irregular shapes, the 33 bones are divided into 5 parts, namely the first seven vertebrae are called cervical (cervical) bones, the next twelve vertebrae form the spine (thoraxal) with a thicker distal part. Than the proximal part (which has a different thickness of the structure), the next five vertebrae are the lumbar spine (lumbar), the five vertebrae of the groin (sacrum), the lower part of the vertebrae is called the (coccyx) [1]. Objects that have different thicknesses, one of which is the thoracic vertebral column. Thoracal is thicker distal than proximal [2].

On radiological examination of the vertebrae, the difference in the thickness of the thoracic vertebrae causes differences in the intensity of radiation reaching the detector so that the image quality and the dose received by the patient is different in the superior and inferior parts. The difference in radiation intensity can be reduced by using the heel effect anode technique. Anode Heel Effect is the intensity of radiation emitted from the cathode end of the x-ray tube is greater than that emitted at the anode end. The Heel Effect anode is usually used to examine objects that are long but have unequal thicknesses, while having to produce the same density. Usually the Anode Heel Effect is used for examination of objects that have different thicknesses, one of which is the thoracal. Thoracal is thicker distal than proximal [2].

To produce the same density distal and proximal, it must be arranged that the distal part which has more thickness than the proximal part is placed under the cathode and the proximal part is placed under the anode. So that the resulting image will have the same relative density between the distal and proximal parts of the thorax [3].

A previous study conducted [4] showed a significant difference in the dose to the testes between the anode in the distal part and the anode in the proximal part, while the anode was in the distal part and the anode in the proximal part there was no significant difference for the ovaries.

With the different thickness of the object, the radiation intensity received by the patient in the proximal and distal parts is different, so that the dose received and the quality of the resulting image are also different. In radiological examinations that are often carried out in hospitals, the location of the anode and cathode is rarely considered so that more often the anode is in the inferior part, resulting in low-density radiographs of the inferior part. In addition to the effect on the image, of course, the anode hell effect affects the adiation dose produced due to different density intensities, but there has never been a test on the difference in radiation dose with the location of the cathode in the inferior part of the thoracolumbar radiographic examination.

2 Method

The research design is a descriptive study with quantitative data types regarding the difference in radiation dose on the application of the heel effect anode to the thoracolumbar examination with the location of the cathode in the proximal and distal sections. The location of data collection was carried out in the Radiology laboratory of the University of 'Aisyiyah Yogyakarta. In this study, the whole body anthropomorphic panthom was used as a prop of the patient's head to avoid the risk of radiation dose given during the

Fig. 1. Measurement of dose with the cathode located in the proximal part

study. The method of research is to measure the radiation dose at the same point 3 times, in addition to evaluating the contrast value in the radiographic results.

3 Result

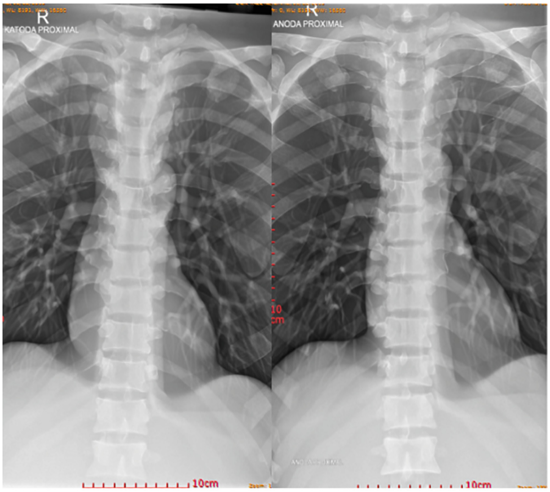
The research was conducted at the Radiology Laboratory of the University of Aisyiyah Yogyakarta. The object of this research is phantom anthropomorphic whole body as a human substitute prop to prevent direct radiation exposure (Fig. 1). The exposure factors used in this study were 70 kV and 10.5 mAs, 3 times exposure with the cathode located in the proximal part and 3 times exposure with the distal carode in order to obtain the radiation dose value. In addition to measuring the radiation dose, the researchers also measured the contrast in the application of the anode heels effect (Fig. 2).

From the measurement results, the radiation dose data obtained are as follows: (Table 1).

From the table above, it can be seen that the average dose rate value with the cathode location in the proximal part is 55.93 μGy/s, while the dose value with the cathode location in the distal part is 49.66 μGy/s. The higher dose value on thoracolumbar radiographic examination with the cathode located in the distal part is caused by the anatomical shape of the thoracolumbar itself which is greater in the distal than proximal part, so that more radiation is transmitted (Table 2).

4 Discussion

The results of the study above that the radiation dose with the cathode in the proximal part has a higher dose value than the cathode in the distal part. The higher dose value on thoracolumbar radiographic examination with the cathode located in the distal part is caused by the anatomical shape of the thoracolumbar itself which is greater in the distal than proximal part, so that more radiation is transmitted.



(a) (b)

Fig. 2. Results of the AP projection radiograph (a) the distal part is at the cathode (b) the proximal part is at the cathode

Table 1. RESULTS OF RADIATION DOSE RATE MEASUREMENTS.

Cathode Location	**Measurement Results**			**Average**
	X1	**X2**	**X3**	
The cathode in the proximal	55,9	53,3	58,6	55,93
The cathode at the distal	48,40	48,76	49,03	49,66

Table 2. AP PROJECTION CONTRAST VALUES ON THORACOLUMBAR EXAMINATION

Location of Measurement	**Contrast calculation**	
	The cathode in the proximal	The cathode at the distal
Proximal	0,0025	0,05
Medial	0,0025	0,0325
Distal	0,0025	0,035

The same thing was also expressed [4] who measured radiation doses, there was a significant difference in the dose to the testes between the anode in the distal part and the anode in the proximal part, while the anode was in the distal part and the anode in the proximal part, there was no significant difference for the ovaries.

Directly proportional to the radiation dose, the contrast value on thoracolumbar examination has a higher contrast value in the proximal cathode than the distal cathode value. The radiation intensity in the cathode region is greater than in the anode region [5]. According to [2] this is because the intensity of radiation emitted from the cathode end of the x-ray tube is greater than that emitted at the anode end, this phenomenon is known as the anode heel effect.

The intensity difference is more common in the cathode area, in line with the principle of utilizing the heel effect, applying the anode heel effect to clinical practice helps radiographers in obtaining quality images of body parts that show different thickness variations. The patient should be positioned so that the thicker part is at the cathode end of the x-ray tube and the thinner part is under the anode.

To produce the same density distal and proximal, it must be arranged that the distal part which has more thickness than the proximal part is placed under the cathode and the proximal part is placed under the anode. So that the resulting image will have the same relative density between the distal and proximal parts of the thorax [3].

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