



EFFECT of VARIATION of C-ARM ANGLE POSITION to DOSE RATE was RECEIVED in SURGICAL PROCEDURE at the CENTRAL SURGICAL INSTALLATION

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Abstract— An anthropomorphic phantom dose rate measurement has been done in C-Arm room at Central Surgical Installation with surveymeter. Measurements were made with 8 variations of the C-Arm fluoroscopy angle commonly used in the operating procedure, as well as the 1 meter point of measurement against the radiation source. The variations of these angles are 0° , 45° , 90° , 135° , 180° , 225° , 270° , and 315° . The dose rate measurements at a distance of 1 m from the radiation source with angle variations are $380 \mu\text{Sv/h}$, $430 \mu\text{Sv/h}$, $680 \mu\text{Sv/h}$, $29 \mu\text{Sv/h}$, $220 \mu\text{Sv/h}$, $350 \mu\text{Sv/h}$, $1370 \mu\text{Sv/h}$ and $1020 \mu\text{Sv/h}$. The measurement results showed that the highest dose rate at the C-arm angle of 270° and the lowest dose at the C-Arm 1350 angle position. From the measurement results can be seen the effect of angular position used with the acceptable dose rate, the lowest to highest dose rate received based on the angular position in sequence are 135° , 180° , 225° , 0° , 45° , 90° , 315° , 270° .

Keywords— C-Arm, Laju dosis, Fluoroskopi, Phantom Antropomorfik, Titik pengukuran

I. INTRODUCTION

In recent decades, mobile fluoroscopy has contributed greatly to reducing invasive procedures, that is, the cost of being cheaper, facilitating or accelerating recovery and reducing hospitalization time. Initially, fluoroscopy was only used in orthopedic procedures, but now almost every medical field has used fluoroscopy regularly to meet its needs. The fluoroscopy intervention procedure, now growing and increasingly complex, so it sometimes takes more than one hour of fluoroscopy per procedure. This doctors place and support staff close to a radiation source that increases the risk of radiation [1-2].The biological effects of radiation induced can damage DNA (Deoxyribose Nucleic Acid), which of the potential to cause genetic changes; can lead to cancer, skin burns, dermatitis and cataract formation [3]. For that reason, protection measures, especially surgeons and support staff and the people and staff who do not perform the operation [4-5] are required.

One such protection method is to use a shield [6-7]. Shield equivalent to Pb is usually called apron which can be used for several hours every day in radiology, cardiology, gastroenterology, pain management, urology, vascular surgery, orthopedic surgery, neurosurgery, anesthesia and dentistry [8].

To minimize the risk of radiation exposure Surgeons and staff should pay attention to the orientation of fluoroscopic rays to the patient, the total time or duration of exposure, the distance from the X-ray tube as well as the use of personal protective devices and shields [9]. The surgeon's position during operation determines the amount of radiation exposure received, according to the inverse square law which says that the exposure decreases proportionally to the square of the source and object distance [8]. In operation of fluoroscopy for surgery can use a tube voltage of 40-120 kVp. The voltage is capable to producing a dose rate of 73,000 $\mu\text{Sv/h}$ so that shielding is required to protect staff and patients [10]. In Indonesia Boundary Values The dose of officers and communities is regulated in the regulation of the head of the Nuclear Power Supervisory Agency No. 4 of 2013, which is 20 mSv/year for radiation workers and 1 mSv/year for the general public [11]. In this paper, we reported the results of research on the effect of variation of C-Arm angel position to dose rate was received in surgical procedure at the central surgical installation.

II. MATERIALS AND METHODS

The measurement of phantom anthropomorphic dose rate of the tissue-equivalent thorax-abdomen PBU-50 was performed using a Fluke 451P-DE-SI-RYR surveymeter. Phantom quantitatively determine the level of exposure at various locations and the distance from C-Arm. Fluoroscopy was performed using C-Arm with tube number 1P885199/S548843 at 64-110 kV tube voltage and tube current of 1.6-7.5 mA and Image Intensifier 21.5 cm diameter, to determine the distance was used by meters measurement. The measurement procedure was recommended by Badman et al, phantom is positioned close to the Image Intensifier. The X-ray tube is positioned at angle variations of 0° , 45° , 90° , 135° , 180° , 225° , 270° , 315° and measured dose rates with surveymeter. Fluoroscopy is performed with the same duration and at the distance of 1 m seen the scheme of Figure 2.1.

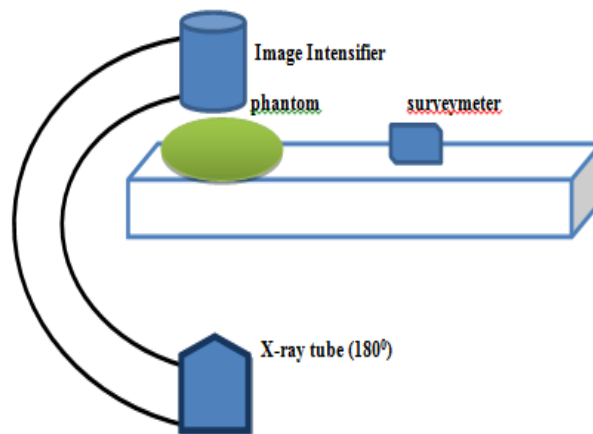


Fig. 2.1. Dose rate measurement scheme at a distance of 1 m from radiation source

The calculation was determined by referring to inverse square law with equation 2.1. The attenuation of X-ray beam is exponential because some of the beam is absorbed by the material it passes.

$$d_1^2 D_1 = d_2^2 D_2 \quad (2.1)$$

With:

d = distance of source with observation point

D = radiation dose at observation point

III. RESULT AND DISCUSSION

The results of the measurements shown in Table 1 illustrates that dose rate at position 1 m to source with angle variation, tube voltage variation and tube current in accordance with Automatic Exposure Control (AEC) and Automatic Brightness Control (ABC) on C-Arm. The AEC in the radiograph system functions to automatically adjust the radiographic engineering factor (most often the tube current and exposure time/mAs) to provide a constant signal intensity at the image receptor in response to differences in patient thickness, X-ray tube energy, focal distance of the detector and other technical factors. Similarly, in the fluoroscopy system, the AEC controls the kerma water for the Image Intensifier.

TABLE 1
THE RESULTS OF THE MEASUREMENT OF THE DOSE RATE AT A DISTANCE OF 1 M FROM THE SOURCE PREMISES 8
ANGLE VARIATIONS

| Position of the x-ray tube | Voltage tube | Tube current | Duration of fluoro | Rate of radiation dose | Dose limit values (μSv/h) | |
|----------------------------|--------------|--------------|--------------------|------------------------|---------------------------|---------|
| | (kV) | (mA) | (s) | (μSv/h) | staff | Patient |
| 0° | 68 | 4.2 | 5 | 380 | 10 | 0.5 |
| 45° | 68 | 4.1 | 5 | 430 | 10 | 0.5 |
| 90° | 68 | 4.5 | 5 | 680 | 10 | 0.5 |
| 135° | 64 | 1.6 | 5 | 29 | 10 | 0.5 |
| 180° | 68 | 4.3 | 5 | 220 | 10 | 0.5 |
| 225° | 110 | 5.0 | 5 | 350 | 10 | 0.5 |
| 270° | 72 | 7.5 | 5 | 1370 | 10 | 0.5 |
| 315° | 73 | 7.4 | 5 | 1020 | 10 | 0.5 |

Based on the measurement results, the highest dose rate received using 270° corner position of 1370 μSv/h and the lowest acceptable dose rate is using 135° corner position of 29 μSv/h. The research results the measured dose rate greatly exceed the specified dose limit value. The effect of the angular position used with the received receiving dose from the lowest to the highest acceptable angular position is 135°, 180°, 225°, 0°, 45°, 90°, 315°, 270°. For consideration of radiation safety in the operating procedure, it would be better to use such corner position priority. C-Arm is an diagnostic imaging tool that uses ionizing radiation and now widely used by almost every medical field for its needs. So should pay more attention to the safety of radiation exposure levels that lasted during operation. The level of radiation exposure should be kept under control and always use apron, Pb globe or thyroid Pb for staff during operation.

In Indonesia Dose Limit Values is adopted from International Commission on Radiological Protection (ICRP). Radiation safety is part of a specific work safety program because the work to be done involves a radiation source [12]. Therefore every radiation worker needs to know the basic radiation safety philosophy that any work that involves the source of radiation should safeguard the safety of oneself, safeguard the safety of others and the environment [13]. Based on table 1 on the results of measuring the rate of dose at a distance of 1 m from a source with angle variation can be illustrated the effect of the angular position on the received dose rate as shown in Figure 3.1.

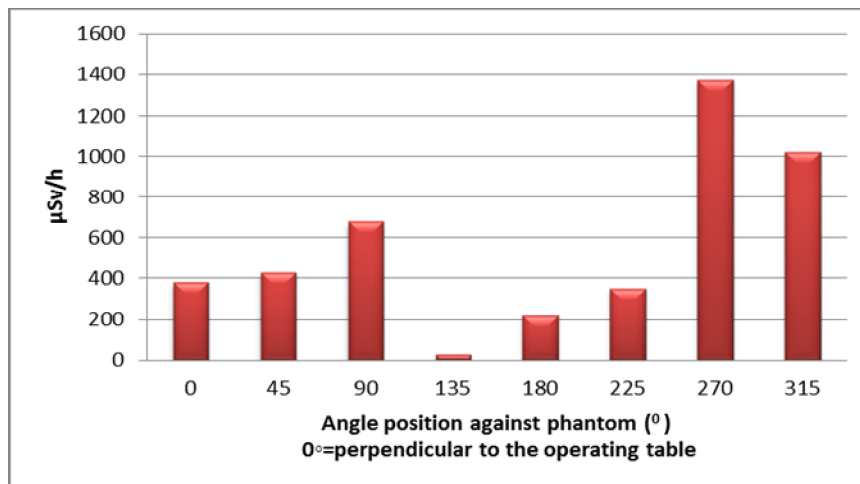


Fig. 3.1. Graphic illustration of the effect of c-arm angle position on the position of surgeon, support staff or opposite patient

IV. CONCLUSIONS

In the use of C-Arm in the Central Surgical Installation related to the cumulative radiation hazard, it is necessary to consider the C-Arm positioning, the distance to the X-ray tube and the need for personal protective equipment and C-Arm space design. In addition, after the use of C-Arm in the operation procedure it is necessary to record the results of radiation exposure for personal dose monitoring. Where practicable, during using C-Arm in operation procedures, personnel or operations staff away from radiation sources.



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