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Determination of Phantom Image Resolution Gamma Camera Mode with Spect Equipment Using Tc^{99m} on Variation of Detector Distance

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ABSTRACT: *Nuclear medicine is one of the medical sciences that uses open radiation sources in assessing organ function. One of the modalities in nuclear medicine is gamma cameras. It is important to pay attention to the spatial resolution of gamma cameras that are routinely every week to ensure the gamma camera plane works optimally so that it can produce more accurate image quality and sharper images. By determining the value of FWHM assisted by the matlab program so that the value of spatial resolution is obtained. In the matlab program, the FWHM value is calculated using the ESF and PSF method. The ESF and PSF methods provide information about the magnitude of the FWHM value caused by blurring around the edge object. In this study we used several detector distances to get the best spatial resolution values. With variations in the distance of the detector affect the image that is getting bigger and there is image blurring. The value of spatial resolution obtained at a distance of 15 cm is 0.047 lp / mm, 20 cm which is 0.055 lp / mm and at a distance of 25 cm which is 0.054 lp / mm. The most optimum value is obtained at a distance of 20 cm from the detector with a spatial resolution value of 0.055 lp / mm. At a distance of 20 cm with angular variation obtained a spatial resolution value of 0° is 0.023 lp / mm, at an angle of 90° is 0.055, at an angle of 180° that is 0.018 lp / mm and 270° is 0.058 lp / mm. The optimum spatial resolution value is obtained at an angle of 270° which is 0.058 lp / mm. Quality Control of spatial resolution of images through FWHM calculations can be calculated using the ESF and PSF methods in the Matlab program. The Importance of Quality Control Phantom image spatial resolution of gamma camera mode on SPECT devices or gamma cameras optimally.*
KEYWORDS*: gamma cameras, spatial resolution, FWHM, ESF and PSF methods.*

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I. INTRODUCTION

Nuclear medicine is a specialization in medicine that uses open radiation sources to assess the function of an organ, diagnose and treat diseases (Martha, 2014). According to PERKA BAPETEN Number 17 of 2012, nuclear medicine is an activity of specialist medical services that uses open radioactive sources from core disintegration in the form of radionuclides and / or radiopharmaceuticals for diagnostic, therapeutic, and clinical medical research purposes, which are based on physiological, pathophysiological and metabolic processes (BAPETEN, 2012).

In the medical world, nuclear medicine, which is intended to obtain information on physiological functions and radiopharmaceutical distribution in an organ (Critchly, 1993).imaging modalities are a common thing to talk about. This is due to the importance of imaging modalities for understanding organ images or even organ conditions without surgery (Bushberg et al, 2002). One modality that is often known in the field of medicine is imaging techniques. Important acquisition in imaging is the area between spatial resolution and sensitivity (Graham, 1995). In gamma cameras, spatial resolution resolution can be resolved by the efficiency and linearity of photomultiplier and collimator tubes. Therefore, spatial gamma camera resolution must be monitored every week to ensure optimal conditions and performance (Prekeges et al., 2011). Especially for digital imaging, spatial resolution examined the ability of imaging systems to fully accurately select objects in two dimensions. Digital images with smaller pixel sizes have better spatial resolution. Spatial resolution can be known by the value of Full Width at Half Maxsimum (FWHM) which is the width of the graph of the intensity of the position of the distribution function. FWHM can be used to determine the quality of images obtained. The method of measuring spatial resolution to get the function against the expected position of the distribution function is: Modulation Transfer Function (MTF), Edge Spread Function (ESF), Line Spread Function (LSF) and Point Spread Function (PSF) (Pahn et al., 2015). But the easiest method to consider and practical is the method of using ESF. The ESF method which is an indirect edge distribution function also gives a value for the point distribution function (PSF). To assist in managing images that are often used by one program is matlab.

Matlab is a programming language that can be used on medical imaging. Matlab can read various image formats. The Matlab program is often used in spatial resolution analysis on radiological modalities such as CT (Dhawan, 2008). In this study using a gamma source, radifarmaca Tc-99m, which was injected into acrylic phantom at a range of detector distances to obtain the maximum value of spatial resolution at a certain distance.

II. METHODS

The gamma camera is a tool used to make the image of the body's organs for further observation of the activity and distribution of radiopharmaceuticals that have been injected in the subjects of the study sample. The subject of the study sample is phantom acrylic as a substitute for the human body. Acrylic phanthom used is cylindrical in size 50 mm in diameter and 2 mm in thickness as shown in Figures 1 and 2.

Figure 1. Acrylic phanthom

(a)

(b

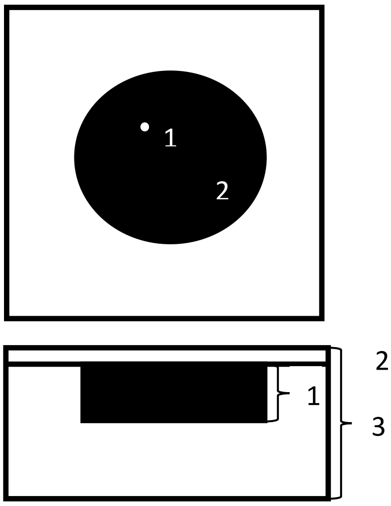


Figure 2. AcrylicPhantom dimension scheme

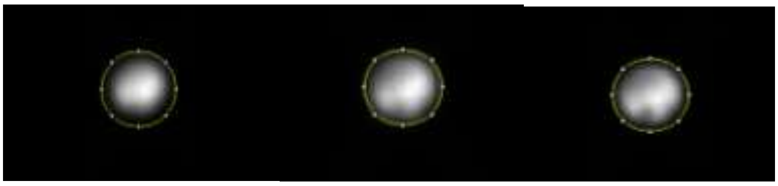
(a) Top view: 1. Radiopharmaceutical filling hole, 2. Acrylic phantom, and 3. Acrylic phantom place.

(b) Side view: 1. Acrylic phantom thickness 2 mm, 2. Acrylic phantom cover thickness 0.5 mm, and 3. Acrylic 5 mm Acrylicphantom thickness

Radiopharmaceutical preparation Tc^{99m} was carried out by preparing a vaccum vial (sterile bottle) which would be filled with Radiopharmaceutical Tc^{99m} from the Tc^{99m} generator with the activity used which was 5 mCi. Tc^{99m} radiopharmaceuticals are injected using a syringe of 5 mCi to acrylic phantom. Acrylic phantoms that have been injected with radioactive Tc^{99m} are placed in the table and given a distance between the ISO center and the detector. Variation in distance used is 15 cm, 20 cm and 25 cm. image capture at a distance of 20 cm with several rotation angles. From the image results, radiopharmaceutical counts can be obtained by determining the Region of Interest (ROI). The extent of ROI follows the form of Phantom acrylic recorded in the image. The test target in this study is in the area of the object point and edge area. At this point and edge target, the Full Width at Half Maximum (FWHM) value of the Gaussian Image function will be obtained. Then the method used in the research in determining the FWHM value is the Edge Spread Function (ESF) method. To get the function of the edge distribution, do ROI crooping on the edge area. Then the value of the function of the ESF is obtained, the value of the ESF is differentiated to obtain the PSF value to get the FWHM value and the value of spatial resolution. By getting a value from each distance it can be seen from a distance of 15 cm, 20 cm and 25 cm which gets the best spatial resolution value (maximum) and produces the best image. And get the best resolution value from changes in angle 0 sudut, 90°, 180° and angle 270° at a distance of 20 cm.

III. RESULTS AND DISCUSSION

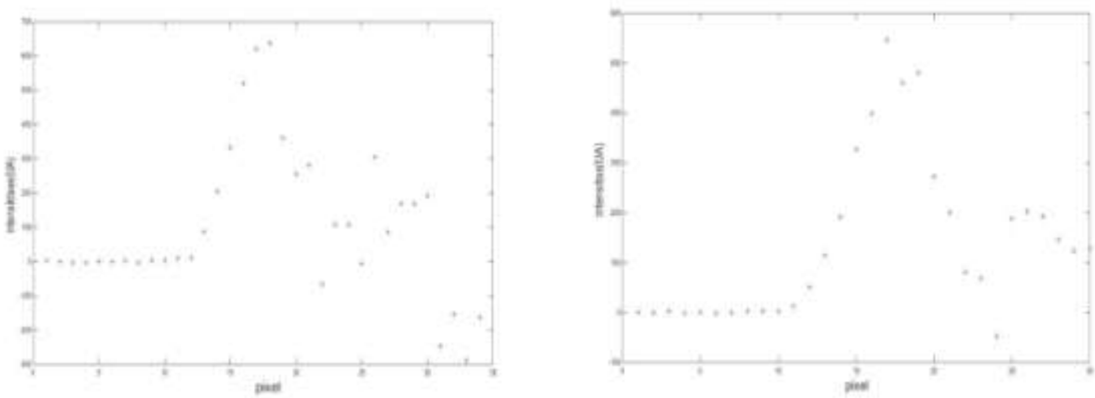
In this study using a cylindrical acrylic phantom with a diameter of 50 mm with a hole size as small as possible with a syringe size of 23 mm. After elution and obtaining a radiopharmaceutical which is then injected into the phantom until it is completely filled and placed on the isocenter on the SPECT device and measured the distance that will be used to retrieve the data. The phantom that has been discanning will produce an image. The resulting phantom image can be seen in Figure 3. The results of the image show differences in image results due to differences in distance detector with phantom acrylic. This is due to the emission of gamma radiation from the radiopharmaceutical used by the detector. The distance between the detector and source greatly affects the image produced. The distance close to the detector produces a smaller and sharper image because more emissions from gamma radiation are received by the detector and vice versa. As in figure 4.2, at a distance of 25 cm, the image is getting smaller from a distance of 20 cm and 15 cm. In Figure 4.1 the magnification of each image is obtained. The farther the distance of the detector from the source, the greater the magnification of the image with the size of the acrylic Phantom measuring 50 mm. At a distance of 15 cm magnification of 58 mm, at a distance of 20 cm by 65 mm and at a distance of 25 cm by 69 mm. From these data, the distance of the detector from the source is the greater the magnification.



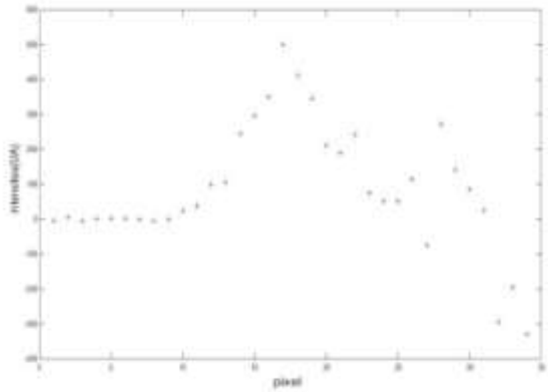
(a) (b) (c)

Figure 3. Acrylic phantom scanning results (a) at a distance of 25 cm, (b) at a distance of 20 cm, and (c) at a distance of 15 cm

The ESF and PSF method will then get the value of Full Width at Half Maximum (FWHM) from the Gaussian image function and the value of spatial resolution. The ESF method which is an edge distribution function which indirectly also gives a value for point distribution function (PSF). After cropping the ROI at the edge area, the edge distribution function (ESF) is obtained. to get the point distribution function (PSF). PSF is an image obtained from a very small point object that can be defined in two dimensions. The FWHM measurement process is an indicator of the quality of spatial resolution of the image. To get the spatial resolution value, the calculation of the FWHM value obtained from the PSF method (figure 4) is calculated. Variation of distance is carried out to determine the ratio of FWHM values and spatial resolution values. Variation in distance used is 15 cm, 20 cm and 25 cm.



(a) (b)



(c)

Figure 4. PSF method for different distances (a) 15 cm, (b) 20 cm and (c) 25 cm.

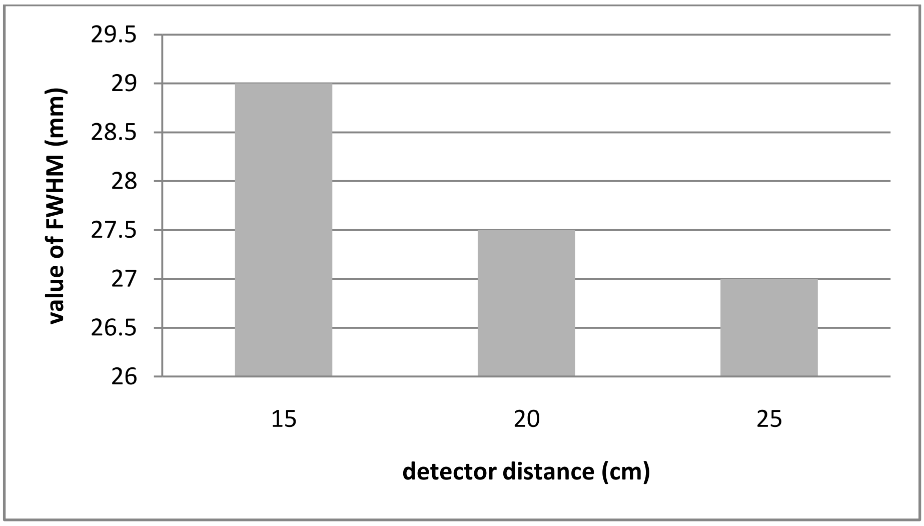


Figure 5. Graph of the effect of detector distance on the value of FWHM

The tendency of the smallest FWHM value is at a distance of 25 cm compared to the distance of 15 cm and 20 cm, this is due to changes in distance that can cause the size of the image produced, the smaller the size of the image at greater distance that affects the FWHM value. The value of FWHM at a large distance is small and vice versa, the value of FWHM is greater, the distance is small and the results of the images obtained are greater. niliaspasail resolution affects the height of the curve and the half-width width (FWHM). the width and height of the wave curve can affect the value of FWHM. The value of spatial resolution obtained and the value of spatial resolution. At a distance of 15 cm, the value of spatial resolution is 0.047 lp / mm, for a distance of 20 cm, which is 0.055 lp / mm and at a distance of 25 cm is 0.054 lp / mm. From these data the highest spatial resolution values obtained at a distance of 20 cm. the value of FWHM at a distance of 20 cm is greater than the distance of 25 cm but the height of the peak of the wave curve is higher so that the value of spatial resolution at a distance of 20 cm is greater.

Measurement of FWHM results and Spatial Resolution with detector rotation at a distance of 20cm

The distance of the dector used is at a distance of 20 cm with the angles used namely 0 yaitu, 90°, 180° and 270°. At each corner scaning is done. Using the same phantom phantom acrylic and 5 mCi activity. The FWHM value obtained affects the value of spatial resolution. On the PSF graph, it is known that the intensity values from each angle have different values so that the peak height of each curve affects the value of spatial resolution. From the angular changes produced the value of spatial resolution which tends to be the same or still can be seen in Figure 6. The value of spatial resolution is obtained from the FWHM value which is not much different . The spasail resolution value obtained at an angle of 270° is 0.023 lp / mm, at an angle of 0° is 0.055 lp / mm, for an angle of 90° that is 0.018 lp / mm and at an angle of 180° which is 0.058 lp / mm. The highest spasail resolution value is at an angle of 180°. At an angle of 270 and 90 sama the shape of the wave curve is almost the same because the retrieval of scanning data on the side of the phantom so that the value of the spatial resolution obtained is not much different . at 0̊ angle and 180̊ angle planar scanning is done so that the data generated is almost similar and the value of spatial resolution is not much different.

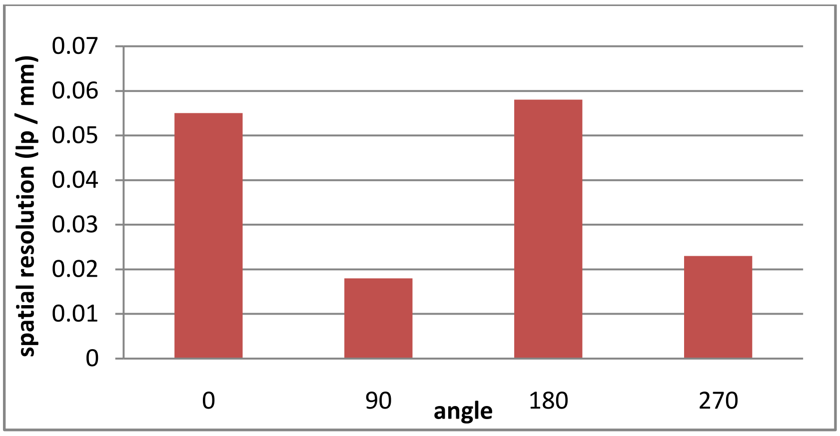


Figure 6. Graph of the effect of the value of spatial resolution on angular changes in the range of 20 cm

IV. CONCLUSION

Based on the results of the discussion that has been carried out, it can be concluded that each distance of different detectors can affect the image results the farther the distance the detector, the greater the image produced and the image will occur image blurring. The maximum spatial resolution value on the gamma camera tool with the ESF and PSF method in the Matlab program is a distance of 20 cm ie 0.055 lp / mm with a distance of 20 cm the rotation angle 270̊ is 0.054 lp / mm.

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