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ACCURACY ANALYSIS OF FLUID VOLUME MEASUREMENT AND CALCULATION METHODS ON MULTISLICE COMPUTED TOMOGRAPHY

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ABSTRACT

Background: Multislice Computed Tomography (MSCT) is utilized for the measurement of bleeding volume in hemorrhagic stroke patients. This is very necessary to determine the right medical action. Errors in measurement can lead to suboptimal medical measures taken. Objective: to analyze the measurement and calculation of fluid volume by automatic and manual methods on the volume of fluid contained in the phantom on MSCT. Methods: The type of research is quantitative experimental with the sample used is a phantom made of polyethylene (Dacron) filled with irregular milk liquid as much as 10 volume variations. The research instruments used were worksheets and interview sheets. Data processing and analysis are descriptive by getting the average value. Results: Measurement and calculation of irregular volume of 10 ml, 20 ml, 30 ml, 40 ml, 50 ml, 60 ml, 70 ml, 80 ml, 90 ml, and 100 were done automatically on the CT scan plane and manually using the formula ½ A x B x C. The automatic method had an average volume difference of 1.39% and the manual method had an average volume difference of 6.88%. The automatic method has a small volume difference. Conclusion: the measurement and calculation of volume with the automatic method has a better accuracy value than the manual method. The results of these measurements and calculations are highly dependent on the accuracy of precise segmentation techniques on the object.

Keywords: multislice computed tomography, volume, automatic, manual

INTRODUCTION

Computed Tomography Scanner (CT Scan) is a technology that utilizes X-rays that have attenuated when passing through objects and then captured by a detector. The computer analyzes the signal from the detector so that it can reconstruct a picture of a piece of the human body (1)(2).

The importance of the use of CT scans in the field of medicine, of course, is the development of scanning technology used to increase sophistication, accuracy, and precision in diagnosing. Multislice Computed Tomography (MSCT) is a seventh generation CT Scan that has the ability to produce 3D images with large volume coverage in a very short time, improve image quality with thinner slice thickness so that it can be used for volume measurement and improve spatial image resolution. (3)(4)(5) .

Multislice Computed Tomography (MSCT) is utilized for the measurement of bleeding volume in hemorrhagic stroke patients (6)(7)(8). This is very necessary to determine the right medical action. Errors in measurement can lead to suboptimal medical measures taken(6). Hemorrhage volume can be determined by automatic method through software on CT scan aircraft and also manual method (9)(10)(11).

The measurement and calculation technique of the automatic method is done by determining the ROI (Region of Interest) in the area to be calculated by providing a boundary line. ROI (Region of Interest) is made on each slice where bleeding is found. After all bleeding is given ROI (Region of Interest), the volume will automatically be calculated and displayed (9).

The automatic method measurement and calculation technique is carried out by determining the ROI (Region of Interest) in the area to be calculated by providing a boundary line. ROI (Region of Interest) is made on each slice where bleeding is found. After all bleeding is given ROI (Region of Interest), the volume will automatically be calculated and displayed (9).

Manual method measurement and calculation techniques are performed by multiplying the ROI area (length and width) of the largest hemorrhage. After that, it is multiplied by the number of slice thicknesses in the bleeding area, then multiplied by a constant (0.52)(6).

Another technique for calculating bleeding using the formula ½ A x B x C (A = length, B = width, C = height or thickness of the slice) (9), Calculation of 1/3 A x B x C with A (length). B (width), and C (height or thickness of the piece)(12), and 2/3SH calculation with S (large area of the axial slice) and H (height).

Volume measurement by manual calculation is strongly influenced by the shape and size of the hemorrhage. In regular hemorrhages, the manual measurement method has a smaller volume difference than the automatic measurement method, but in irregular hemorrhages and hemorrhages with more than one point, the manual measurement method has a higher volume (overestimade) than the automatic measurement method (9).

RESEARCH METHODS

The research design used is quantitative research with experimental methods. The research was conducted at the Radiology Installation of the hospital in November 2020. The population and samples used were phantoms made of polyethylena (Dacron) filled with liquid (milk) as a substitute for irregular fluids as much as 10 volume variations, namely 10 ml, 20 ml, 30 ml, 40 ml, 50 ml, 60 ml, 70 ml, 80 ml, 90 ml and 100. The research instruments were worksheets and interview sheets. Processing and analysis of the results in this study using quantitative analysis. The results of the automatic and manual method calculations are included in a table. each method will look for differences in volume to the volume of liquid contained in the phantom by calculating the volume difference. The volume difference in this study is converted in the form of percent by dividing the difference value by the value of the volume of liquid contained in the phantom then multiplying by one hundred percent. This value will be compared and used as the basis for drawing conclusions.

RESULTS AND DISCUSSION

Measurement and calculation of volume on the phantom containing 10 variations of irregular liquid volume, namely 10 ml, 20 ml, 30 ml, 40 ml, 50 ml, 60 ml, 70 ml, 80 ml, 90

ml, and 100 were performed automatically on the CT Scan plane and manually using the formula ½ A x B x C.

A. Automatic Measurement and Calculation Results

Volume measurement and calculation of automatic method using volume calculation software available in CT Scan tool. The first thing the user does is to open the exam list then select the patient name, it will open the series of images in one folder. Select in the folder the image that has the most series then click once. In the applications 3D protocols column select Reformat then the image will open. Scroll the axial image up and down to pay attention to the part that has fluid from the part where the fluid starts to appear until the liquid disappears.

After knowing the liquid condition, the user determines the ROI (Region of Interest) by using the segment tool then selecting paint on slice. To outline the liquid to be calculated. ROI (Region of Interest) is made on each slice where liquid is found.

Area delimitation is done one by one from the first slice where there is liquid to the last slice before the liquid disappears. After all liquids are given ROI (Region of Interest), check whether the entire liquid area has been covered. If so, the user selects apply, then on the display tools click measure volume. Hover over the liquid area then click and automatically the liquid volume results will appear. The following are the results of measurements and volume calculations obtained through the automatic method:

Table 1. Results of Measurement and Calculation of Liquid Volume with Automatic method

Automatic (ml)	Phantom (ml)	Difference (ml)	Percentage (%)
10,5	10	0,5	5,0
19,9	20	-0,1	-0,5
31,1	30	1,1	3,7
41,0	40	1,0	2,5
51,1	50	1,1	2,2
60,4	60	0,4	0,7
70,5	70	0,5	0,7
79,6	80	-0,4	-0,5
90,8	90	0,8	0,9
99,3	100	-0,7	-0,7
Mean		**0,42**	**1,39**

Based on the results of the measurement and calculation of the volume of liquid with the automatic method as shown in table.1, the average volume difference to the volume of irregular liquid in the phantom is 1.39%. The volume difference with the automatic method is displayed in the form of a graphic figure 1. as follows:

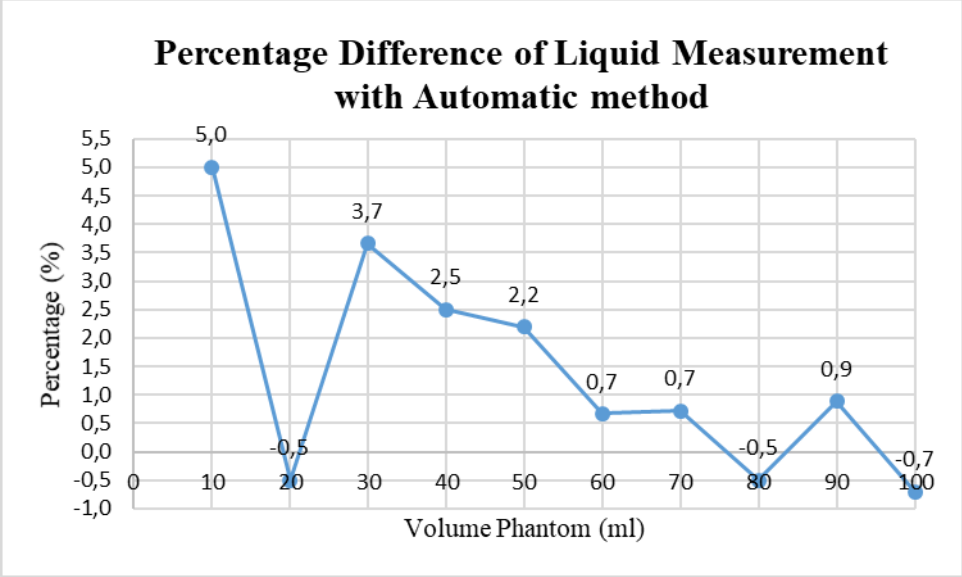

Figure 1. Charts of Automatic Calculation Differences

B. Manual Measurement and Calculation Results

The measurement is done by using the distance measurement software available on the CT Scan tool. The first thing the user does is to open the exam list then select the patient name, it will open the series of images in one folder. Select in the folder the image that has the most series then click once. In applications 3D protocols select Reformat then 30 image will open. Scroll the axial cut images up and down to pay attention to the part with fluid. Select the image that appears the largest fluid in the axial cut to get the maximum length (A) and width (B). then select the highest visible fluid image in the sagittal or coronal cut to get the maximum height (C) by using the measure distance in the tools display column. The number obtained will then be entered into the manual calculation formula which is 1/2 A x B x C.

The following are the results of measurements and volume calculations obtained through the manual method:

Table 2. Results of Measurement and Calculation of Liquid Volume by Manual method (1/2 AxBxC)

Automatic (ml)	Phantom (ml)	Difference (ml)	Percentage (%)
10,3	10	0,3	2,5
20,8	20	0,8	4,0
38,6	30	8,6	28,7
51,1	40	11,1	27,6
62,7	50	12,7	25,4
63,3	60	3,3	5,4
59,5	70	-10,6	-15,1
94,5	80	14,5	18,1
70,9	90	-19,1	-21,2
93,5	100	-6,6	-6,6
Mean		**1, 49**	**6,88**

Based on the results of the measurement and calculation of the volume of liquid in the manual method table.2 using the formula 1/2 A x B x C, the average volume difference to the volume of irregular liquid in the phantom is 6.88%. The volume difference with the manual method is displayed in graphic figure 2 form as follows:

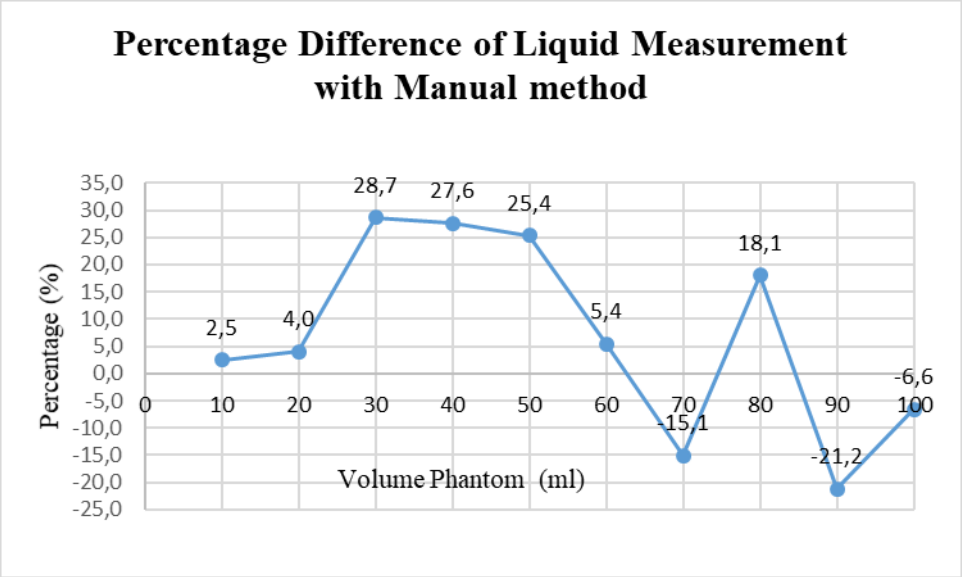

Figure 2. Charts of Manual Calculation Differences

The automatic method has a small difference value to the volume of liquid contained in the phantom so that it is close to the actual volume while the manual method has a large difference value to the volume of liquid contained in the phantom so that it is far from the actual volume therefore it can be concluded that the measurement and calculation of volume with the automatic method has a better accuracy value compared to the manual method.

CONCLUSION

The results of measuring and calculating the volume of fluid with the automatic method on the volume of fluid contained in the phantom on multislice computed tomography obtained an average volume difference of 1.39%. The results of measuring and calculating the volume of fluid with the manual method on the volume of fluid contained in the phantom on multislice computed tomography with the use of the formula 1/2 A x B x C obtained an average volume difference of 6.88%. The automatic method has a small difference value to the volume of fluid contained in the phantom so that it is close to the actual volume while the manual method has a large difference value to the volume of fluid contained in the phantom so that it is far from the actual volume therefore it can be concluded that the measurement and calculation of volume with the automatic method has a better accuracy value than the manual method.

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