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The effect of slice thickness variations on the quality of the image and value bleeding volume on DSCT brain examination

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ABSTRACT

Background

Slice thickness is the thickness of the incision or slice of the object that is examined by CT Scan. One component that affects the quality of the image is the selection of slice thickness. Changes in slice thickness can affect artifacts, spatial resolution, image detail and noise. Slice thickness is the thickness of the slices or pieces of the object to be examined, the value is between 1 mm - 10 mm according to clinical needs. In general, a thick size will produce a picture with low detail and vice versa thin size will produce a picture with high detail [1, 3].

Method

Research design used in this study is experiment methods with Posttest Only Design from 10 patients. The research instrument used was a worksheet and questionnaire. Data collection methods used is by direct field observation during the study. Data collection is done by filling the questionnaire by one senior radiographers and one radiologists. In this study, the data that has been obtained is inserted into the table to suit the thickness of slices used is 1,5 mm, 3 mm and 5 mm, and made distribution table. Statistically processed using a factor ANOVA test (F test), with (f) 95% table to find the influence of the thickness of the slices with the picture quality and value bleeding, which revealed significant differences limit if (f) count value > from (F) table.

Result

The results showed slice thickness 1,5 mm, 3 mm and 5 mm indicates a difference in the value of the volume but no significant bleeding and thick slices also showed variations exist influence The picture quality on axial cuts DSCT Brain.

Keywords: *Slice Thickness, Bleeding Volume, Image Quality, Examination Techniques DSCT*

INTRODUCTION

CT Scan is one of the diagnostic support tools that uses a combination of X-rays and a computer to obtain images or images in the form of variations of the human body slices [1, 2]. As a radiographic tool to support the diagnosis, CT Scan is expected to provide an overview informative, especially anatomical information. To simplify and speed up the operation of the MSCT aircraft, the parameters of each inspection are usually programmed, for example KV, mAS, slice thickness, pitch, scan

time, number of ranges, etc. so that the operator does not need to set parameters except for certain cases. Choosing thinner slice thickness will result in closer volume measurements according to Simpson's method. [4-6]

Slice thickness is the thickness of the incision or slice of the object that is examined by CT Scan. One component that affects the quality of the image is the selection of slice thickness. Changes in slice thickness can affect artifacts, spatial resolution, image detail and noise. Slice thickness is the thickness of the slices or pieces of the object to be examined, the value is between 1 mm - 10 mm according to clinical needs. In general, a thick size will produce a picture with low detail and vice versa thin size will produce a picture with high detail. [1, 3]

Components that affect the quality of CT scan images are spatial resolution, where spatial resolution is influenced by geometry factors which are factors related to the process of data acquisition, among others: focal spot size, size and ability of the detector and slice thickness. Other components have contrast resolution, noise and artifacts, [3]

The brain is the most metabolically active organ in humans and is the network that uses the most energy in the entire human body. The brain and spinal cord as a nerve center are protected by a membrane called meninges [7]. Brain hemorrhage can occur due to vascular disease, mainly due to spontaneous cerebral hemorrhage due to hypertension and arteriosclerosis, it can also occur due to ruptured aneurysms that cause subarachnoid bleeding. Fresh hemorrhage is in the form of a round border with a firm border, with a density between 55 - 90 HU. On the third day, crescent absorption is seen as perifocal swelling that increases SOE (Space Occupying Effect) until cerebral infarction occurs [8]. Bleeding is often caused due to trauma. Bleeding due to trauma which is often measured bleeding volume include: Epidural Bleeding (Epidural Hematoma / EDH), Subdural Bleeding (Subdural Hematoma / SDH), Intracerebral Bleeding (Intra Cerebral Hematoma / ICH) [8]

According to [1], the CT Scan examination technique is as follows: Position of the supine patient, head fist against gantry, Slice thickness used is in the base region of 5 mm and in the cerebellum area of 10 mm to describe the intracranial structure. According to [9] CT Scan Head examination procedures are as follows: The thickness (slice thickness) used is 10 mm. Meanwhile According to [10] CT Scan head examination procedure: Made with a thickness of 3-4 4.8 mm at the base of the orbit and a thickness of 9.8-10 mm at the cerebellum / cranial posterior cerebral fossa. Based on the author's observations during his fieldwork at Siloam Hospital Kebon Jeruk, he often paid attention to the experiences and habits in radiology installation at Siloam Hospital Kebon Jeruk. Without ever comparing the slice thickness with one another to the quality of each image. This study was conducted to see the effect of slice thickness on the quality of DSCT Brain images and bleeding values using a computer device count so that later readers will get information about the use of slice thickness variations of 1.5 mm, 3 mm and 5 mm on the image quality of DSCT Brain axial pieces.

METHODS

This research is experimental. This research was conducted at Siloam Hospital Kebon Jeruk Hospital for 3 months from May to July 2012. The population was obtained from all DSCT Brain examinations with bleeding clinics that performed DSCT Brain examinations at Siloam Hospital Kebon Jeruk Radiology installation and the samples were DSCT brain patients totaling 10 patients, with 1 person, 3 slice thickness treatments were varied with variations of 1.5 mm, 3 mm and 5 mm on the image quality of DSCT Brain axial pieces, so there were 30 slices in total. Methods Data collection in this study was carried out by direct observation in Siloam Hospital Kebon Jeruk Radiology installation and field experiments including: Slice thickness experiment used for head examination Following the examination or SOP for CT CT scan of the head in Siloam Hospital Kebon Jeruk.

The research instrument was in the form of filling out questionnaires from radiologists and senior radiographers who were competent in the field of CT scans for image quality of each Slice thickness. And worksheets to record the results of calculating the volume of the results of different thickness reconstruction slices. Data obtained from the questionnaire and subsequent worksheets are processed statistically, then the data is analyzed

and discussed the data are statistics analyzed using the statistical method of the one-way ANOVA method

RESULTS AND DISCUSSION

This experiment was carried out on 10 patients with each patient made as many as 3 slices of the thickness of the reconstructed reconstruction, so the total number was 30 pieces. The specifications of the DSCT aircraft used for scanning are as follows

a. Airplane name: DSCT SIEMENS
b. Type: Somatom Definition
c. Rotation speed: 0.33 s
d. Slice thickness: 1.5
e. Number of detectors: 2 x 64

The CT Scan aircraft used is the type of SOMATOM DEFINITION DUAL SOURCE, manufactured by SIEMENS medical in 2008

Image 1. Siemens Dual Sources CT Scan

The patient is scanned with the protocol head routine. Position the supine patient on the examination table with the patient's hand beside the body. The patient was instructed not to move during the examination. Set the examination table, gantry and turn on the collimator lamp parallel to the MCP (Mid Coronal Plane) from the patient's head with the second collimator line above the vertex of the patient's head ± 3 fingers. Then the patient is put into the gantry, then goes to the consul operator's desk to scan the patient. A topogram is made from the head CT scan. After getting a topo-gram, then scanno-gram is made again on the monitor. Shots were taken on a 5 mm base and 8 mm cerebrum, with Coronal and Sagittal cuts using 1 mm slice thickness. After scanning, the patient is removed from the gantry and instructed again so that the patient waits for ± 1 hour if there is a radiologist on duty. While the scan results are reconstructed to allow for filming / printing.

Reconstruction results

The picture below is (a) 1.5 mm brain cut picture, (b) 3 mm brain cut picture, (c) 5 mm brain cut picture used to obtain subjective quality assessment data from respondents. first picture on topogram picture, picture 2 axial pieces to see bone clarity, picture 3 to see ventricular stricture, picture 4 to see brain structure, picture 5 to see how the image contrasts, picture 6 to see to see patches whether in the picture, and the 8th picture is to see artifacts or images that have nothing to do with the object.

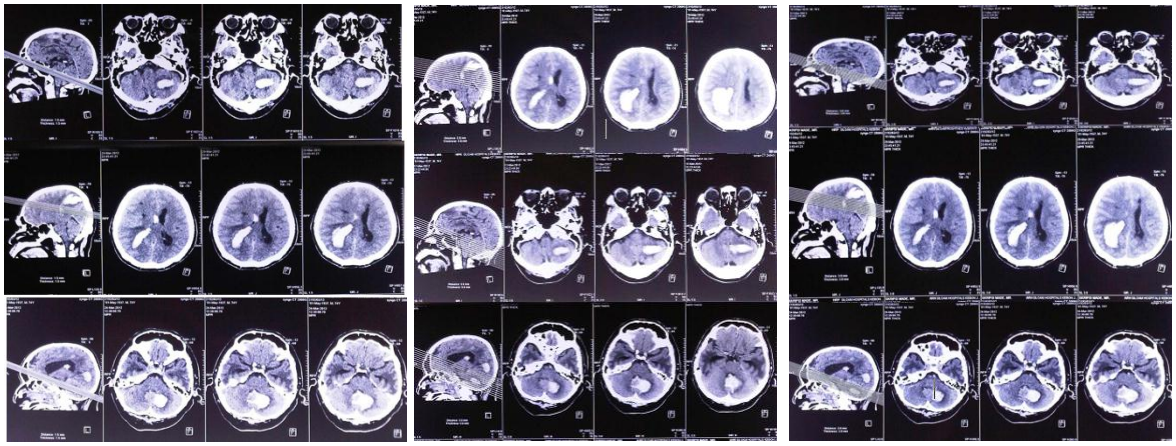

Figure 1. (a) Slice Thickness 1,5 mm, (b) Slices thickness 3 mm, (c) Slice thickness 5 mm

Table 1. The all value of Slice thickness reconstructions

No	Patients	Slices Thickness		
		1,5 mm	3 mm	5 mm
1	A	3.5	2,66	1,66
2	B	3.5	3.0	1,83
3	C	3.5	2.33	1,5
4	D	3.5	2.66	1,66
5	E	3.5	2.33	1,66
6	F	3.5	2.16	1,66
7	G	3.5	2.66	1,66
8	H	3.5	2.16	1,66
9	I	3.5	2.5	1,66
10	J	3.5	2.66	1,66
(∑)		35	25.12	16.61
Average		3.5	2.5	1.6

From the recapitulation results table of the respondents, it was found that the highest average of the respondents was in the 1.5 mm slice thickness namely 3.5, 3 mm = 2.51 and the slice thickness of 5 mm = 1.6 The above shows the difference in the average value of each slice thickness be used.

Test statistics

One-way ANOVA test to show whether there are differences in each slice thickness used on the image quality.

Table 2. Descriptive of Quality of Subjective Assessment Images

Slice Thickness	N	Mean	Deviation Standard	Minimum	Maximum
1,5	10	3.50	0.000	3.50	3.50
3	10	2.51	0.266	2.16	3.00
5	10	1.66	0.077	1.50	1.83

Table 2 shows the differences in each slice thickness used, namely 1.5 mm slice thickness has a mean of 3.50 with a standard deviation of 0.00 minimum value of 3.50 and a maximum value of 3.50, a slice thickness of 3 mm has a mean value of 2.51 with a standard deviation of 0.266 and a minimum value of 2.16 and a maximum value of 3.00 and a slice thickness of 5 mm have a mean of 1.66 with a standard deviation of 0.77 and a minimum value of 1.5 and a maximum of 1.83.

Table 3. Anova results in the quality of 10 patients

Slice thickness	df	F	Sig
Between Groups	2	329.328	.000
Within Groups	27		
Total	29		

From the ANOVA test table above states that there is a difference in the value of the slice thickness to the quality of the picture shown at the value of $p \leq 0.0001$ this value is smaller than the limit value $\alpha = 0.05$ so the conclusion of H0 is rejected.

Table 4. Bleeding values obtained from computer software calculations

No	Patient	Patient Age	*Slice Recon. 1,5* (Cm^3)	*Slice Recon. 3* (Cm^3)	*Slice Recon. 5* (Cm^3)
1	A	42	45.04	37.90	36.40
2	B	69	76.84	67.96	60.95
3	C	21	3.48	2.89	2.85
4	D	54	24.90	19.31	17.81
5	E	79	16.30	11.21	10.90
6	F	54	7.14	6.86	6.47
7	G	50	5.32	4.36	4.19
8	H	54	22.48	22.37	20.12
9	I	63	10.06	8.69	5.86
10	J	28	36.36	26.24	25.80
Total ($\sum$)			24792	20779	19135
Average			24.792	20.779	19.135

Table 4 explains the bleeding values from computer calculations obtained. Can be seen that the slice thickness of 1.5 mm = 24792 has the largest number of bleeding values compared to the value of the slice thickness of 3 mm = 20779 and 5 mm = 19135.

Table 5. One way ANOVA test for bleeding thickness slice

Slice Thickness	N	Mean	Deviation Standard	Minimum	Maximum
1,5	10	24.7920	22.83333	3.48	76.84
3	10	20.7790	19.92970	2.89	67.96
5	10	19.1350	18.21696	2.85	60.95

Table 5 shows the differences in each slice thickness used, namely 1.5 mm slice thickness with mean 24.79 standard deviation = 22.83 minimum value 3.48 and maximum value 76.84, slice thickness 3 mm with mean 20.77 standard deviation 19.92 minimum value 2.89 and a maximum value of 67.96 and 5 mm slice thickness with a mean value of 19.13 standard deviation of 18.21 with a minimum value of 2.85 and a maximum value of 60.95.

Table 6. Results of anova test of quality DSCT image from 10 patients

Slice thickness	df	F	Sig
Between Groups	2	.203	.817
Within Groups	27		
Total	29		

From the ANOVA test table above states that there is no difference in the value of the slice thickness to the volume of bleeding indicated at the value of p = 817 this value is greater than the limit value $\alpha = 0.05$ so the conclusion H0 is accepted.

DISCUSSIONS

From experimental data the effect of slice thickness on image quality with slice thickness of 1.5 mm, 3 mm and 5 mm from the results of respondents in the questionnaire can be seen that:
a. Slice thickness 1.5 mm with bone value = 39 with an average = 3.9, tissue = 40 with an average = 4, spatial resolution = 40 with an average = 4, contrast = 40 with an average = 4, noise = 11 with an average = 1.1 and artifacts = 39 with an average = 3.9.

The total quality of the grade 1.5 mm is 3.5 with an average of 3.5

Slice thickness 3 mm with bone value = 28 with average = 2.8, tissue = 27 with mean = 2.7, spatial resolution = 21 with average = 2.1, contrast = 24 with average = 2.4, noise = 27 with an average = 2.7 and artifacts = 26 with an average = 2.6. **The total overall quality of the 3 mm figure is = 24.7 with an average = 2.47**

Slice thickness of 5 mm with bone value = 13 with average = 1.3, tissue = 10 with mean = 1, spatial resolution = 10 with mean = 1, contrast = 10 with average = 1, noise = 40 with an average = 4 and artifacts = 16 with an average = 1.6. **The total overall quality of the 5 mm figure is = 16.16 with an average of 1.6.**

This proves that the picture quality in each slice thickness is different. This statement is reinforced in the ANOVA test which is stated with p value p≤0001 and from the post hoc analysis data the turkey test shows a difference in image quality with slice thickness of 1.5 mm, 3 mm and 5 mm because the overall p value is ≤0,001. This probability value is smaller than α = 0.05, so the decision is taken that H0 is rejected, meaning that there is a difference in the quality of the image with slice thickness of 1.5 mm, 3 mm, and 5 mm.

Calculation of bleeding volume with computer software shows that the value of slice thickness of 1.5 mm has an average of 24.7, slice thickness of 3 mm has an average of 20.7 and a slice thickness of 5 mm = 19.1 This indicates that the average of the three slice thicknesses above is different and slice 1.5 has the largest average value but, in the one way ANOVA test results obtained from the slice thickness of 1.5 mm, 3 mm and 5 mm there is no significant difference from the three slice thickness expressed by p value = 0.817. This probability value is greater than α = 0.05, so a decision is made that H0 is accepted, meaning that there is no significant difference in bleeding volume in the varying slice thickness

CONCLUSIONS

From the results of the one-way ANOVA test, the results show that there is a difference in the quality of the image with the varying thickness slice thickness of 1.5 mm, 3 mm and 5 mm. This is indicated by the value of p value ≤0,0001. From the post hoc analysis the overall p value of the post hoc test is smaller than the value of α = 0.05, then H0 is rejected, this suggests that there are differences in the image quality of the three different slice thickness reconstructions. Picture quality of 1.5 mm slice thickness reconstruction has an average value = 3.5, 3 mm slice thickness has an average value = 2.5 and 5 mm slice thickness has an average value = 1.6 this shows that the image quality of slice thickness of 1.5 mm is better than slice thickness of 3 mm and 5 mm. Whereas based on the results of the one anova way test, the results show that there is no significant difference in the value of the bleeding volume with the slice thickness recontruction which varies so that the slice thickness of 1.5 mm, 3 mm, and 5 mm can be used to calculate the bleeding volume. show the value of p value = 0.817 From the post hoc test analysis the overall p value of the post hoc test is greater than the value of α = 0.05. This states that there is no difference in the value of bleeding volume by using three different slices of reconstructed thickness. This shows that of the three slices of reconstructed thickness can be used to calculate the volume of bleeding.

Recommendation

Use a thin thickness reconstruction slice to get the best picture quality.

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