ACCURACY OF BLEEDING VOLUME MEASUREMENT USING PHANTOM WITH SEQUENCE AND SPIRAL TECHNIQUES ON HEAD CT SCAN

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INTRODUCTION

- According to Siemens, two techniques can be used on the MSCT scan, namely the sequence technique and the spiral technique, both of which differ in the number of images taken during scanning.
- For the selection of mAs MSCT scan at Siemens, there is no difference between the sequence technique and the spiral technique.
- The selection of high mAs is used to produce images with good detail and also the resulting noise is small but the resulting dose will be high. The helical/spiral technique can perform continuous scanning so that it can overcome eg anatomical registration but the dose is higher.

- A study has been conducted by Kiswoyo (2017) regarding the volumetric calculation of bleeding using the automatic volume method (Software volume Evaluation) and manual method (Broderick) on head MSCT (an experimental study on patients with intracerebral hemorrhage at Haji Hospital Surabaya.) The results of this study are that there are differences bleeding volume from 10 patient data using the calculation of bleeding volume by the automatic method (SVE) and manual method (Broderick) of 3% to 41%, 8 patient data has an average volume difference of 25% which is described from the small bleeding group with irregular shapes (irregular) and 2 patient data had a mean volume difference of 6% described from the small bleeding group with regular shape.

- From the results of the Paired Sample T-test difference between two volumetric calculation methods, namely the automatic volume method by Software Volume Evaluation (SVE) and the manual method by Broderick. The results obtained are the significance value

Research Plan

- 1. Type of research

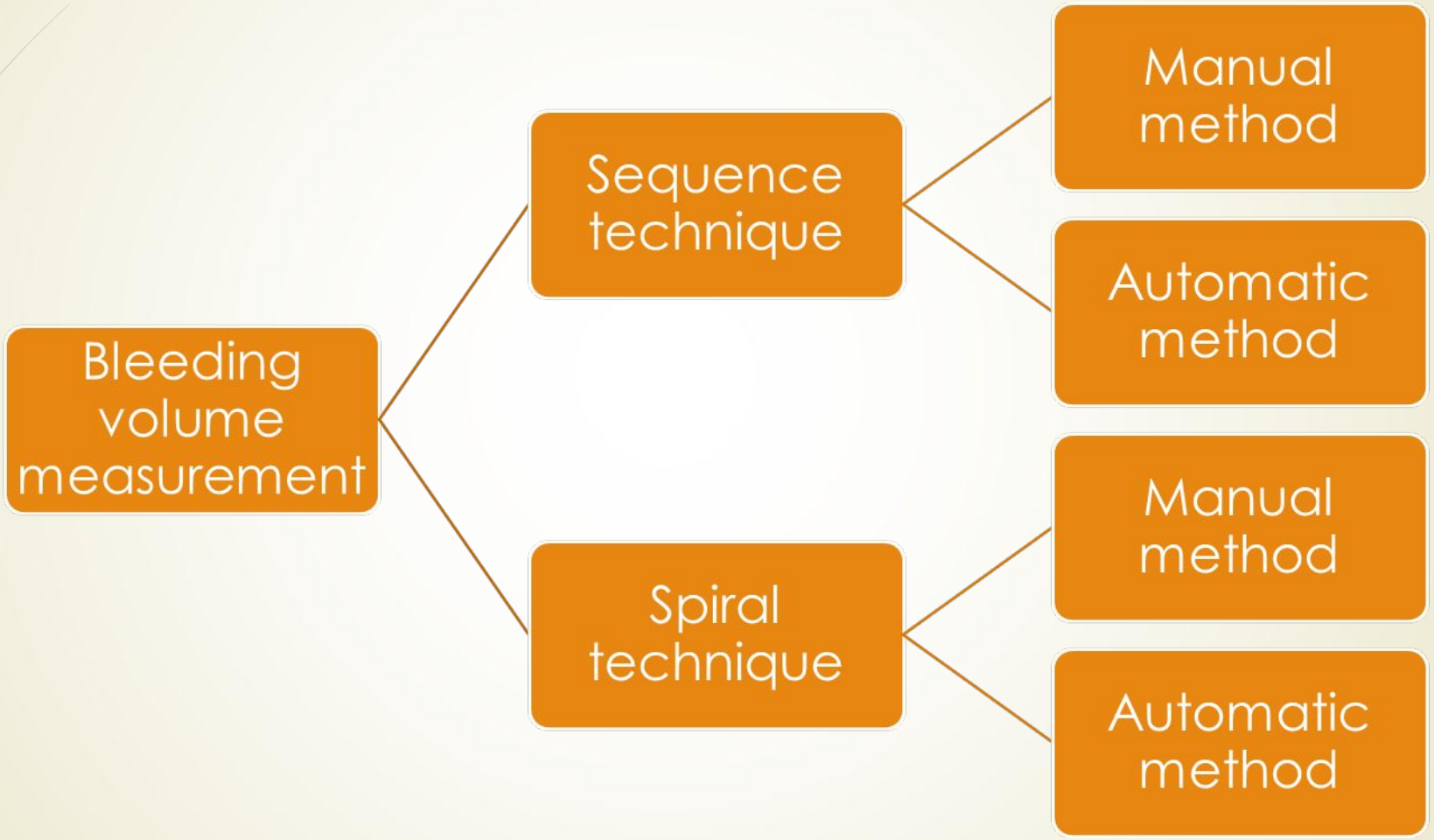
  The type of this research is true experimental quantitative research.

- 2. Time and Place of Research

  Time the study was conducted from July to November 2020. The study was conducted at Muhamadiyah Roemani Hospital, Semarang

- Research on measuring volume bleeding using phantom on the sequence technique and spiral technique on head CT scans was conducted at the Radiology Installation of PKU Muhamadiyah Roemani Hospital Semarang. The research begins by determining the material to be made of phantom, in this study the phantom material used is resin, because this material can be penetrated by x-rays. After getting the appropriate materials, the phantom head is made. After the phantom is made according to the expected design, then scanning is carried out.
- Initial scanning is done to see raw data. Raw data is to get the desired image, but the row data results obtained are difficult to distinguish between phantom and contrast media that represent bleeding using H45s filtering.

Research Design



Research Variable

Independent Variable

spiral and sequences scanning techniques of head CT scan with manual and automatic methods

Dependent Variable

The value of bleeding volume measurement

Controlled Variable

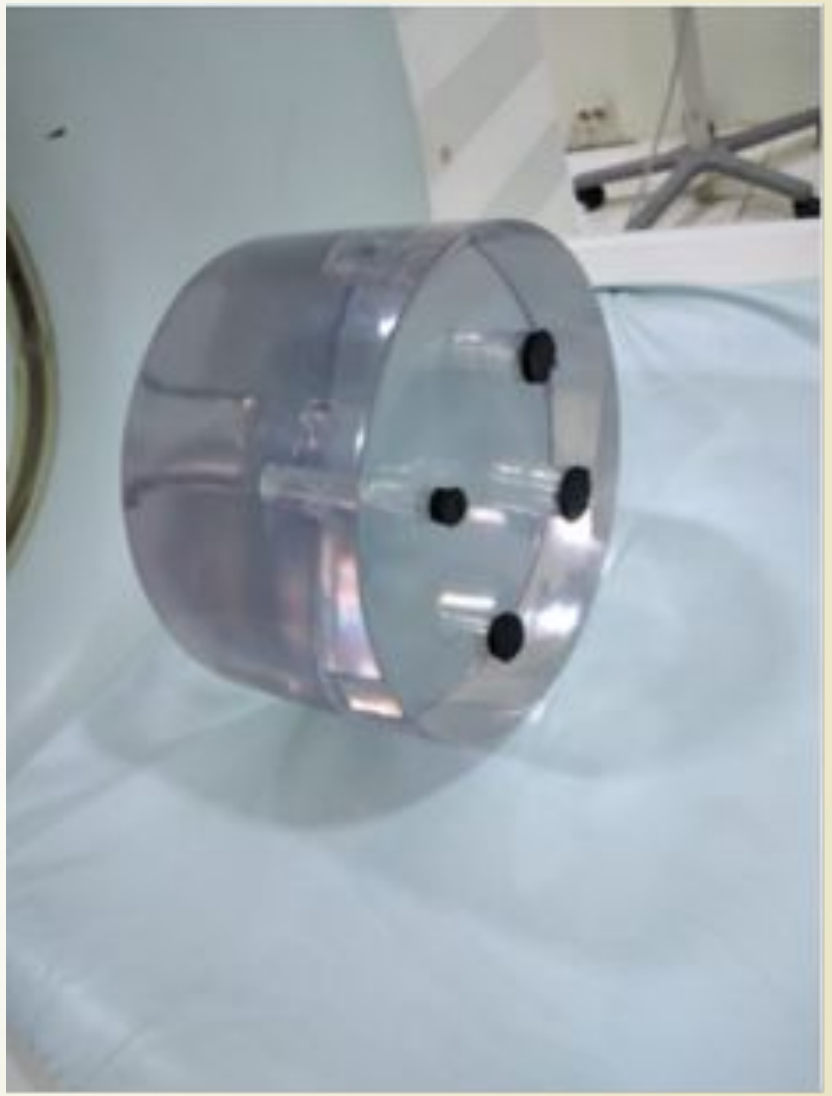
- CT scan machine,
- tube current and exposure time (250 mAs),
- X-ray tube voltage (130 kV),
- field of view (FOV= 200 mm),
- slice thickness (2.5 mm),
- scan time (26.04 s),
- Rotation time: 1 s,
- Filter (H70s), minimum HU 3069 and maximum HU 3071.

Research Steps

- **Step 1 (Phantom Creation)**

a. Material selection. The material used in this research is resin because this material can penetrate X-rays.

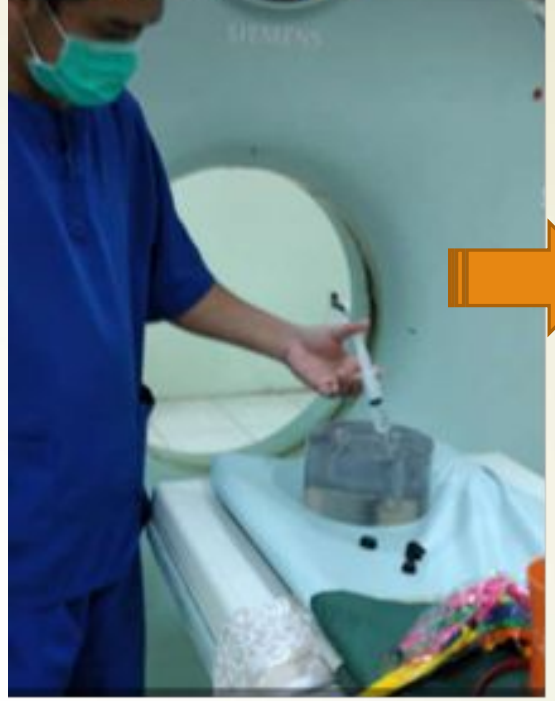
b. Determining the size of the phantom according to the size of an adult human head with a phantom diameter of 20 cm and a thickness of 11 cm, the phantom was made 4 holes with different sizes filled with contrast media as a substitute for bleeding and covered with rubber. The four holes will be filled with contrast media with different volumes of contrast media, namely 3 ml, 5 ml, 7 ml, and 10 ml.



Research Steps

- **Step 2 (Scanning)**

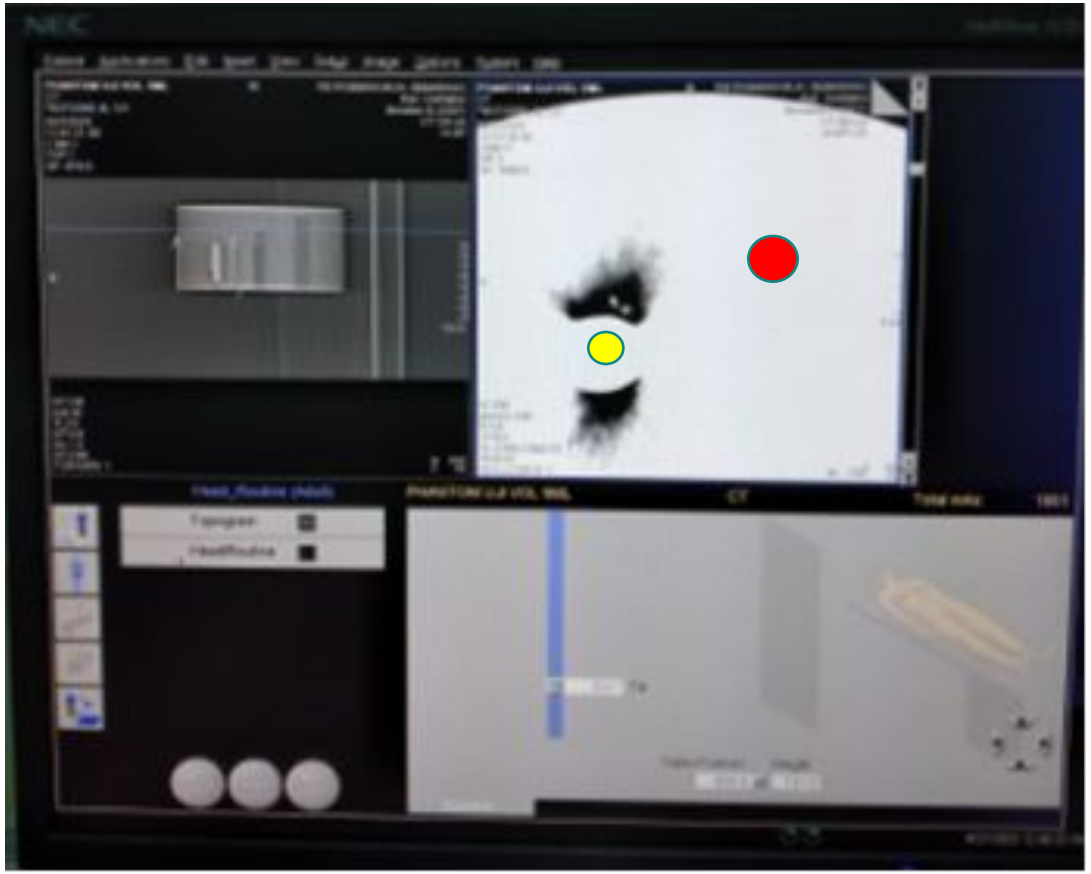
a. Prepare tools and materials (CT scan, phantom head, contrast media, syringe)
b. Place the phantom on the examination table
c. Perform data entry: phantom identity
d. Set scanning parameters: 130kV, 250mAs, FOV= 200 mm, slice thickness 2.5 mm, rotation time 1 s, HU min 3069 and max 3071
e. Insert contrast media using a syringe according to the size of the phantom hole
f. Scan with a spiral at 5 ml (raw data)
g. After viewing the raw data to the desired image is visible, but the results of raw data are difficult to distinguish between phantom and contrast media that represent bleeding, so the best filtering to do as a control is filtering H70s (sharp).
h. Measure the volume of bleeding manually and automatically.



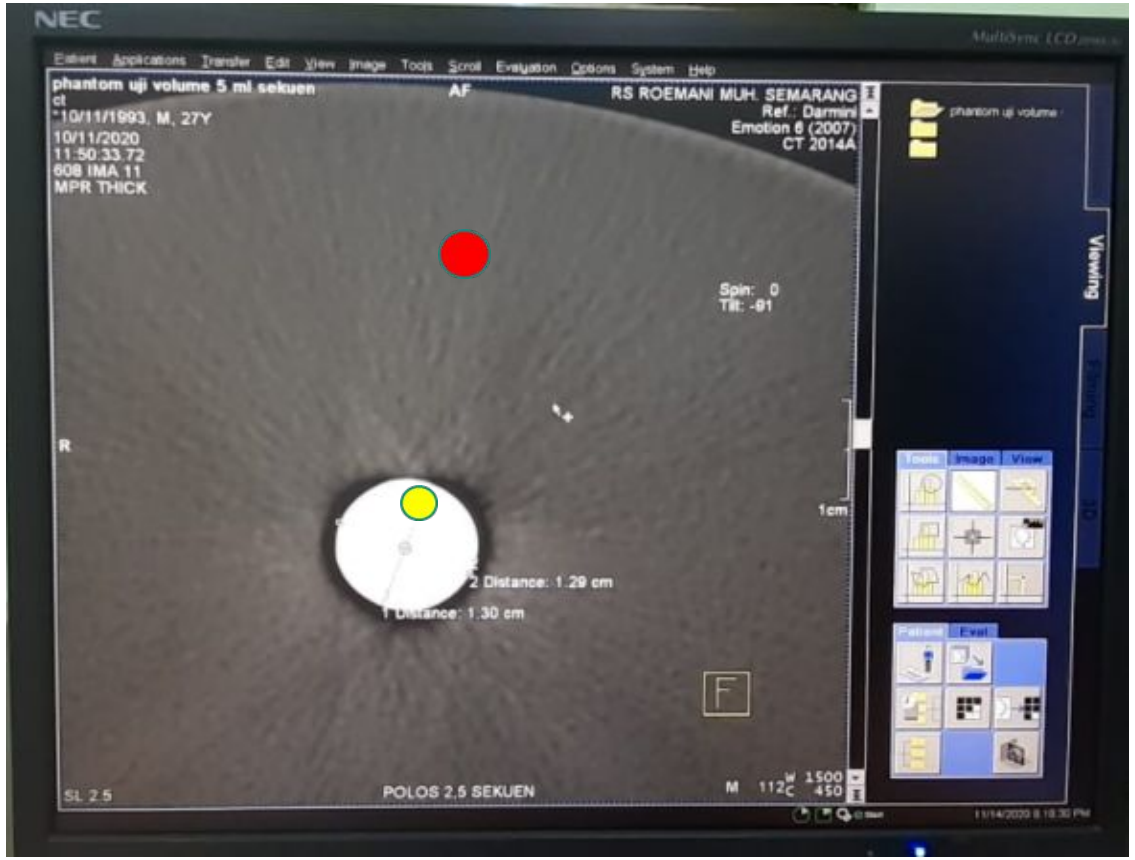
Contrast media filling

Positioning object

Setting parameter



Raw data image using H45s filtration at 5 ml contrast media volume cannot distinguished between phantom (red circle) and contrast media (yellow circle)



Raw data after filtering using H70s at 5 ml contrast media volume can be distinguished between phantom (red circle) and contrast media (yellow circle)

Research Steps

- **Step 3 (Measurement of bleeding)**
- ✔ **The manual method of bleeding measurement**

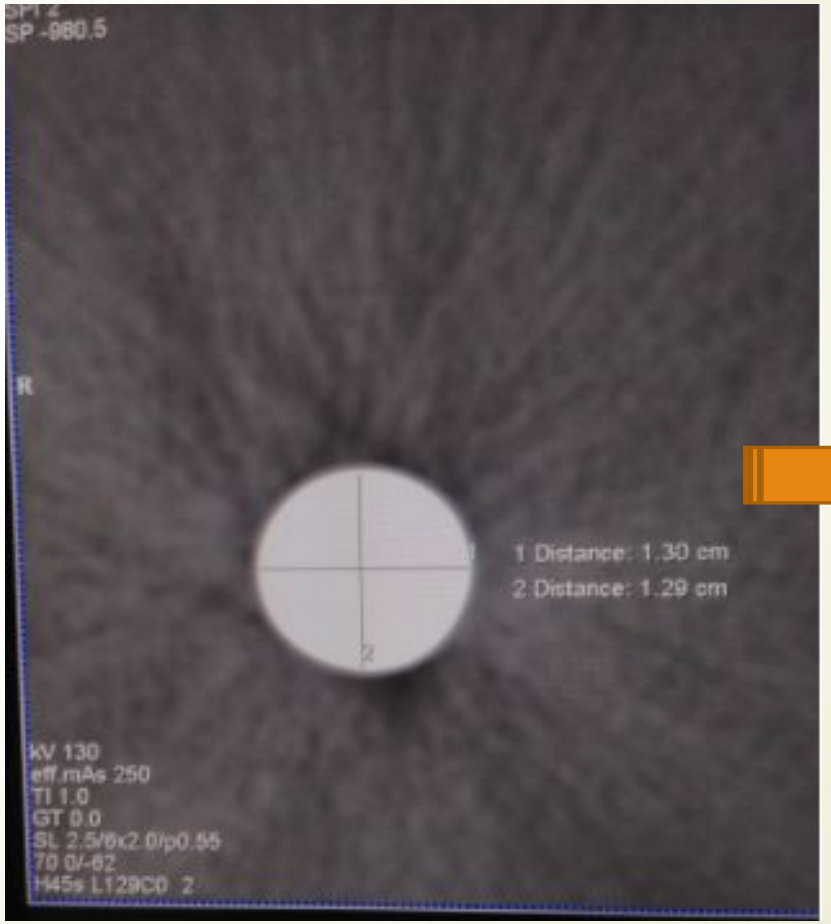
a. Select the middle slice from 21 slices (10th slice)
b. Measure the long diameter and wide diameter
c. Measure the thickness of bleeding with the formula

Volume = A x B x C/2

Note: A = diameter length of bleeding
B = diameter of bleeding width
C = thickness of bleeding

C (thickness of bleeding) is the product of the slice thickness and the number of axial sections where bleeding is present.

d. The results of the bleeding volume measurement data are recorded and tabulated



- volume perdarahan = AxB xC

A= 1,30 cm = 13 mm
B= 1,29 cm = 12,9 mm
C= jumlah irisan = 21; tebal 2,5 mm
= 21 x 2,5 mm
= 5,25 cm = 52,5 mm
Volume perdarahan = A x B x C/2
Volume = 13 x 12,9 x 52,5/ 2

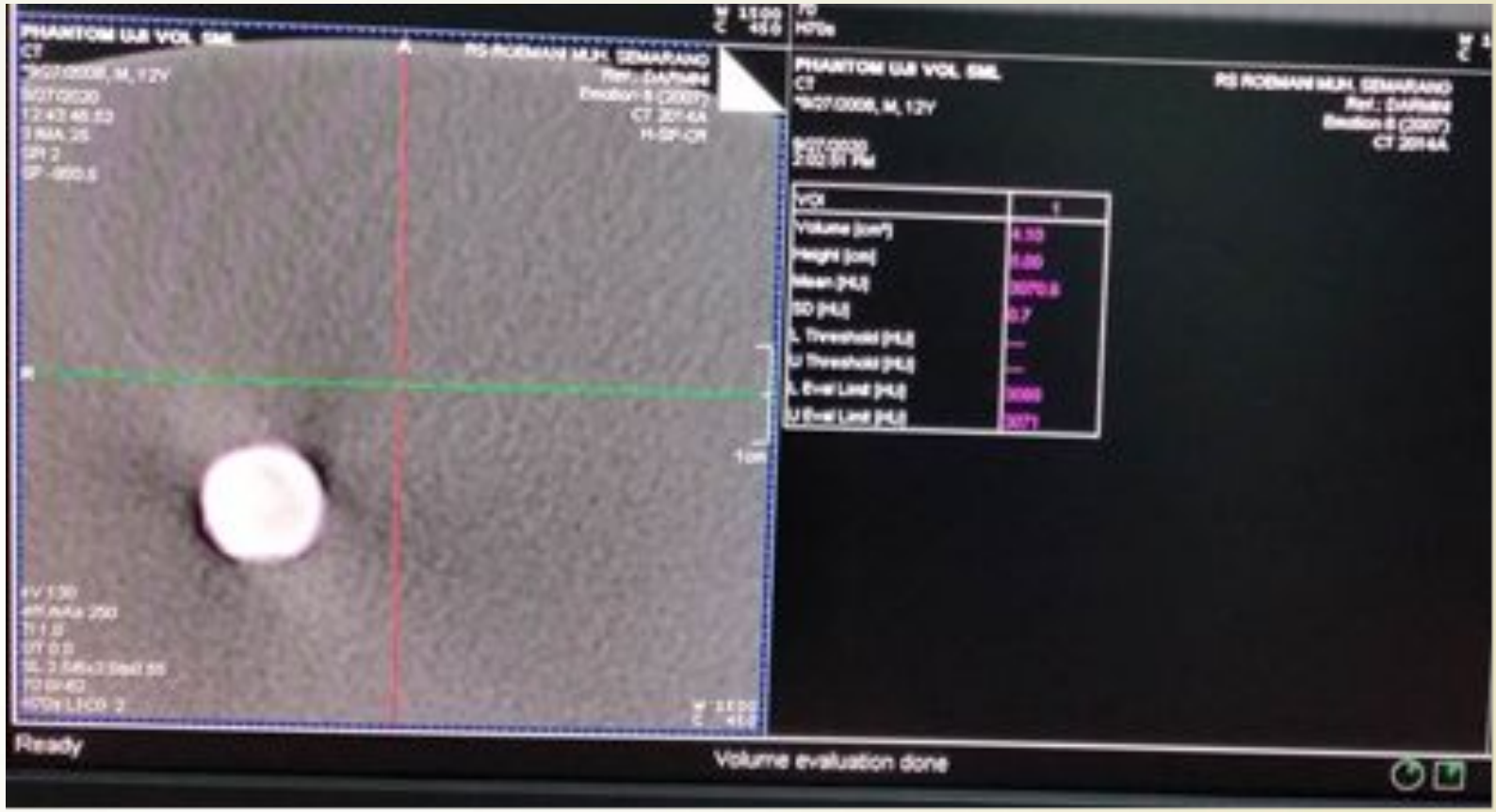
- Volume = 4,402 mm3 ≈4,402 cm3

Research Steps

- **Step 3 (Measurement of bleeding)**
- ✔ **Bleeding measurement automatic method**

a. The scan results are selected volume
b. Select the circle shape tool mark
c. Determine the upper and lower limits of the lateral scan
d. Apply the circle tool to the MK area in the axial section
e. Determine the HU value of the upper HU and lower HU (the minimum HU value is 3069, the maximum HU is 3071)
f. Click on start evaluation
g. We get the value/ size of bleeding
h. Record the result

- Then repeat the same steps for each volume variation of 10 ml, 15 ml, and 20 ml.

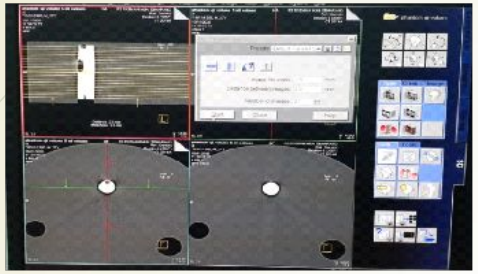
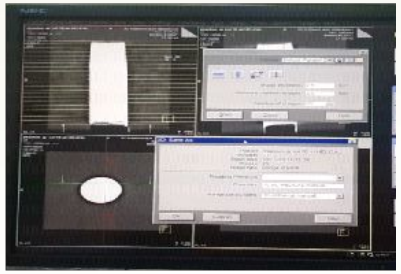
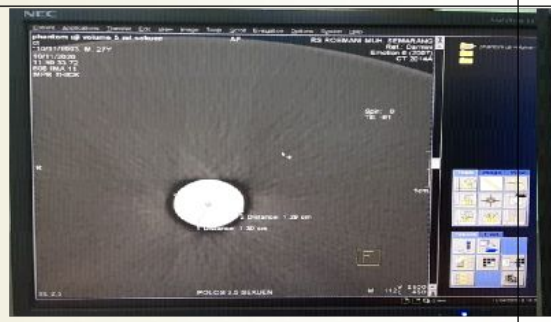
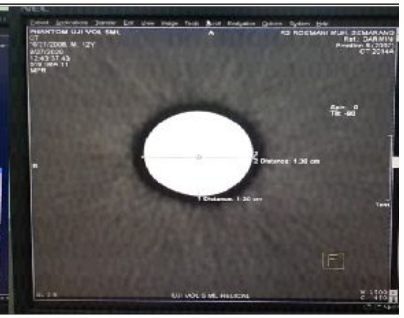


Measurement Method Using Calculation Volume Software is done after the scanning is complete then the bleeding volume is measured starting from the appearance of bleeding to the end of bleeding by localizing (Segmentation). The bleeding area to be measured by freehand ROI on the image. Result obtained was 4.10 mm.

Data Analysis

- The results of the test on measuring the volume of bleeding using the spiral technique and the sequence technique on a CT scan of the head using a processed phantom were then analyzed.
- To determine the value of bleeding volume using the automatic volume method (software volume evaluation) by performing ROI on the bleeding area, for the manual method using the formula V = A x B x C/2 (Huttner et all, 2006).
- To find out the results of measuring the volume of bleeding with spiral and sequence techniques with manual and automatic methods, SPSS program was used descriptively with Friedmen Test followed by Wilcoxon.
- The decision on the research results is that Ho is rejected if the value 0.05 at the 95% confidence level. To find out the value of the standard deviation of the measurement results with the actual volume by looking for the mean value.

RESULT

Pengukuran	Teknik spiral	Teknik sekuen
Scanogram		
1		
2		
3		

Tabel 4.2 Image of the result sequence dan spiral with manual method using 10 ml volume

RESULT

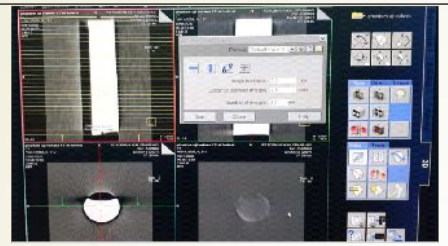
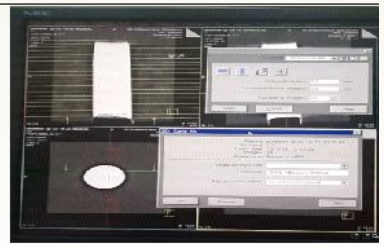
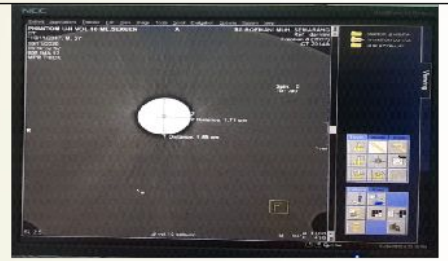
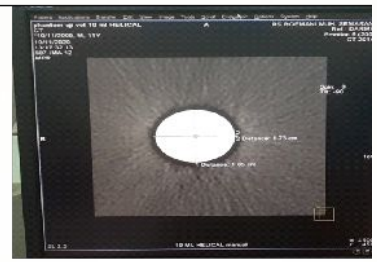
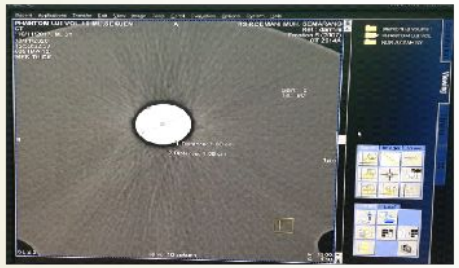
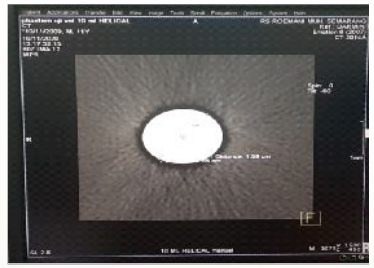
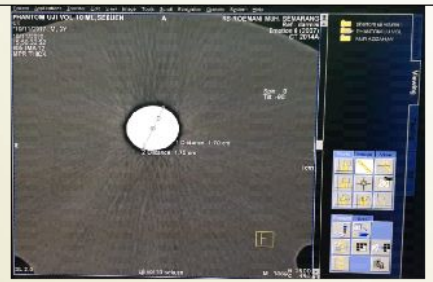
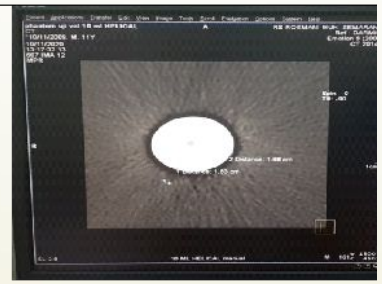
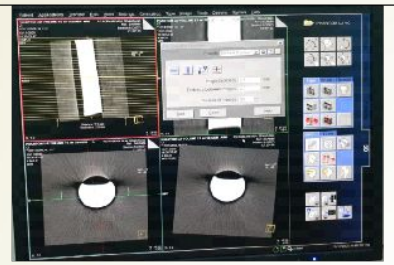
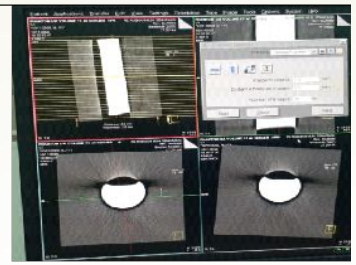
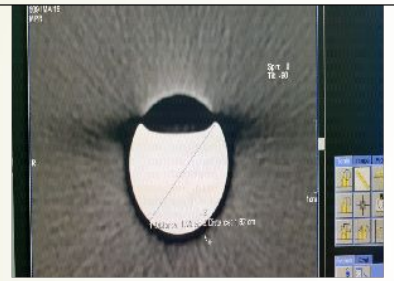
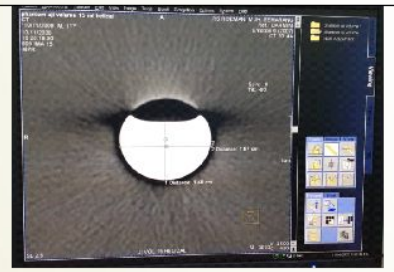
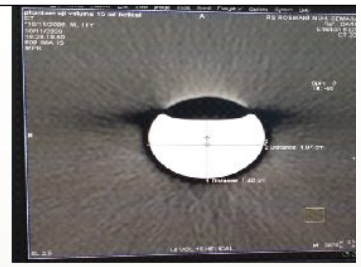
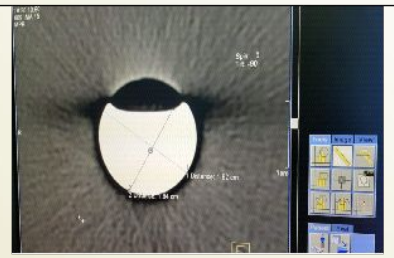
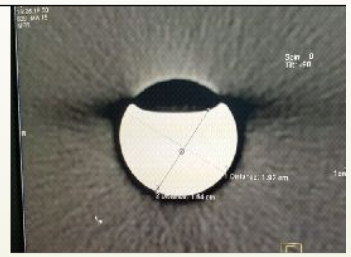
Pengukuran	Teknik spiral	Teknik sequence
Scanogram		
1		
2		
3		

Table 4.3 Image results of manual measurement of sequence and spiral techniques using a volume of 15 ml

RESULT

Pengukuran	Teknik spiral	Teknik Sequence
Scanogram		
1		
2		
3		

Tabel 4.4 Image of the result sequence and spiral with manual methode using 20 ml volume

RESULT

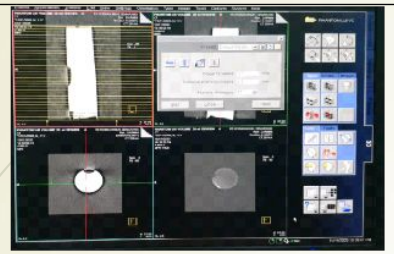
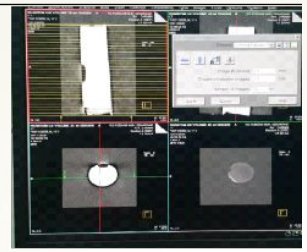
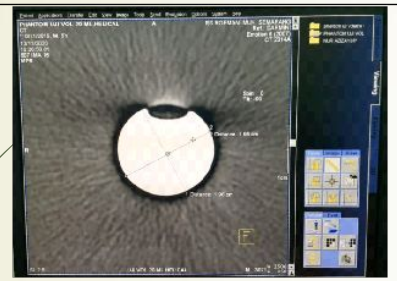
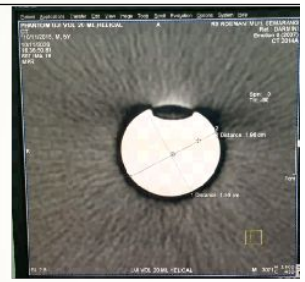
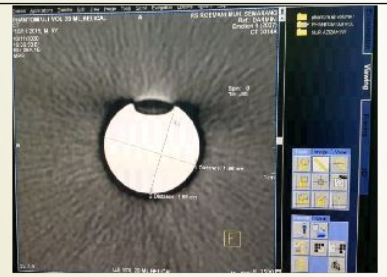
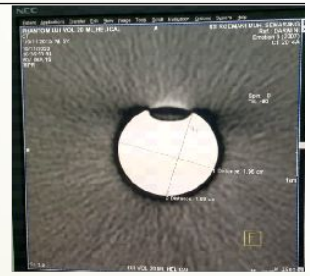
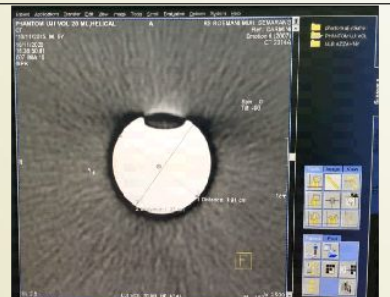
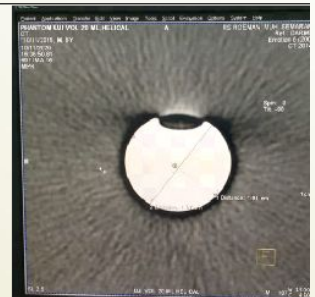
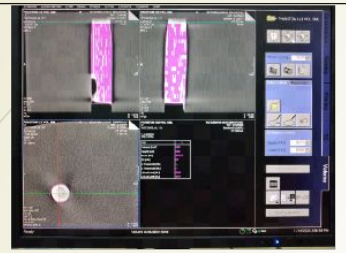
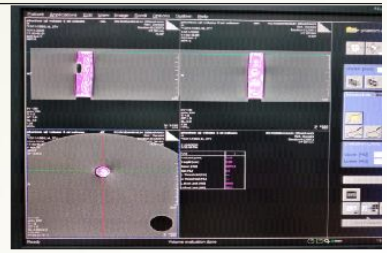
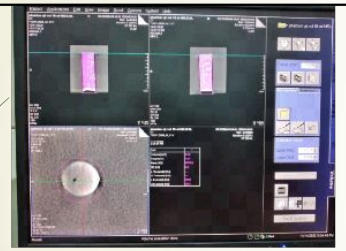
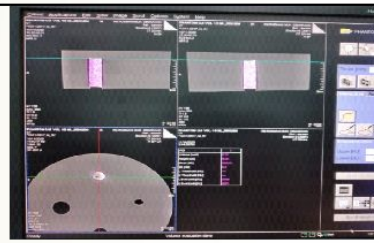
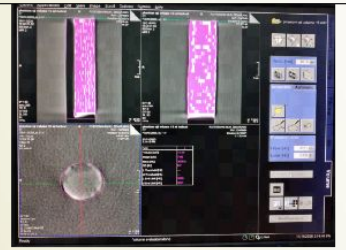
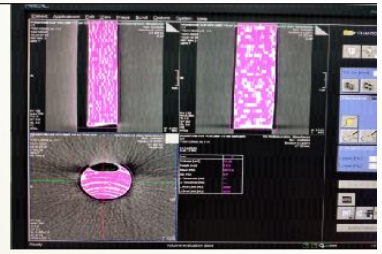
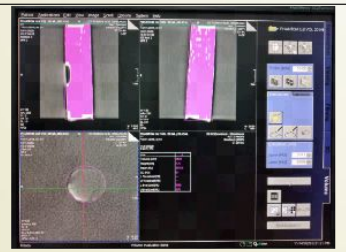
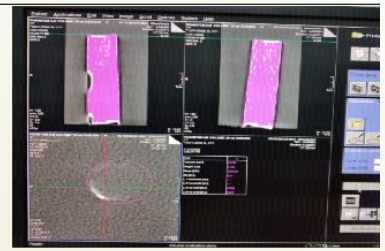
Pengukuran	Teknik Spiral	Teknik sequence
Scanogram		
1		
2		
3		

Table 4.5 Image of the results of spiral technique and automatic sequence method

RESULT

Volume	Teknik spiral	Teknik Sequence
5 ml		
10 ml		
15 ml		
20 ml		

Volume	Nilai Sig.	p- Value	Meaning
5 ml	0,000	< 0,05	there is a difference
10 ml	0,000	< 0,05	there is a difference
15 ml	0,001	< 0,05	there is a difference
20 ml	0,021	< 0,05	there is a difference

RESULT

Table 4.6. The average value of bleeding volume using manual and automatic **spiral techniques**.

Volume	Manual Method (cm^3)	Automatic Method (cm^3)
5 ml	4,39	4,10
10 ml	7,87	8,09
15 ml	11,40	11,12
20 ml	15,05	18,93

Table 4.8. The average value of bleeding volume using manual and automatic **sequence techniques**.

Volume	Manual Method (cm^3)	Automatic Method (cm^3)
5 ml	4,39	3,75
10 ml	8,05	7,27
15 ml	11,72	10,35
20 ml	14,20	13,55

Table 4.7 Different test results of paired samples T-test

Volume	Sig. Value	P- Value	Meaning
5 ml	0,000	< 0,05	there is a difference
10 ml	0,000	< 0,05	there is a difference
15 ml	0,001	< 0,05	there is a difference
20 ml	0,021	< 0,05	there is a difference

Table 4.9 Different test results of paired samples T-test

Volume	Sig. Value	P- Value	Meaning
5 ml	0,000	< 0,05	there is a difference
10 ml	0,000	< 0,05	there is a difference
15 ml	0,012	< 0,05	there is a difference
20 ml	0,000	< 0,05	there is a difference

RESULT

Table 4.10 Value of standard deviation with actual bleeding volume automatic method

Volume	Deviation Standard (SD) of Spiral technique Value	deviation standard (SD) of Sequence technique value
5 ml	0.139	0.139
10 ml	0.270	0.242
15 ml	0.315	0.288
20 ml	0.329	0,376

Table 4.11 Standard deviation values with actual bleeding volume manual method

Volume	Deviation Standard (SD) of Spiral technique Value	deviation standard (SD) of Sequence technique value
5 ml	0,220	0,333
10 ml	0,236	0.376
15 ml	0.351	0.447
20 ml	0.057	0.476

Table 4.11 Average value of standard deviation actual bleeding volume automatic and manual metthode

Automatic		Manual	
Spiral	Sequence	Spiral	Sequence
0,26325	0,26125	0,216	0,408

DISCUSSION

1. The results of the **spiral technique** bleeding volume measurement based on manual and automatic measurement methods

   - The spiral technique is a spiral or helical geometry beam used to obtain volume in a object. In this technique the x-ray tube moves around the patient in a spiral pattern with each scan. This technique produces a single slice rotating x-ray tube. The advantage of this technique is that the time is relatively fast
   - The results of calculating the spiral technique using the manual method, the average values that are close to the actual volume in the spiral technique are 5 ml (4.39 cm3) and 15 ml (11.40 cm3) volumes. While the spiral technique of the automatic method is at a volume of 10 ml (8.09 cm3) and 20 ml (18.93 cm3).
   - The results of the spiral technique calculation research using manual and automatic methods were carried out with a paired sample T Test with a significance value of 5 ml 0.000, 10 ml volume 0.000, 15 ml volume 0.001 and 20 ml volume 0.021 (P-value <0.05) it can be concluded that there is a significant difference in the spiral technique using automatic and manual methods.

DISCUSSION

1. The results of the **spiral technique** bleeding volume measurement based on manual and automatic measurement methods

   - The automatic volume method (SVE) has a longer processing time than the manual method, because the process of making the process of segmenting the bleeding area and determining the HU value according to the type of bleeding
   - Manual volumetric calculations (Broderick) look more complicated according to data and calculations, but the process has a faster processing time. In accuracy, there is a tendency for the volume value of the manual method to be higher because it depends on the shape and size of the bleeding. In bleeding with a regular shape (regular), **the manual method (Broderick) has a very small volume difference value compared to the automatic volume method (SVE), the average percentage value of the volume difference is 6%.** However, for bleeding with an irregular shape (irregular) and bleeding with more than one point (multilobular) the manual method (Broderick) has a higher volume result (overestimated) than the automatic volume method (SVE), the average percentage value of the volume difference is 25%.

DISCUSSION

1. The results of the **spiral technique** bleeding volume measurement based on manual and automatic measurement methods

- According to the researchers, the results in this study used the spiral technique, the manual method, the results that were close to the actual size were at a volume of 5 ml, while in the automatic method the values that were close to the actual volume were at a volume of 10 ml and 20.
- The results of different tests using the manual and automatic methods were different.
- This is in accordance with publications and literature (Huttner et al, 2006) that the **manual method A X B X C/2 is accurate with a fast process for bleeding volumes** for small ones and a significant overestimation of bleeding volume calculations, especially for irregular bleeding. and multilobular.
- According to Cui Wei, et al (2004) volumetric calculations using the automatic volume method (SVE) are strongly influenced by slice thickness or reconstructed slices, thinner slice thickness will result in more accurate volume measurements (Cui Wei, et al, 2004).

Spiral techniques, manual vs automatic

Manual	Automatic
• close to the actual volume • Manual volumetric calculations (Broderick) look more complicated according to data and calculations, but the process has a faster processing time • value of the manual method to be higher because it depends on the shape and size of the bleeding • In bleeding with a regular shape (regular), **the manual method (Broderick) has a very small volume difference value compared to the automatic volume method (SVE), the average percentage value of the volume difference is 6%.**	• has a longer processing time than the manual method • making the process of segmenting the bleeding area and determining the HU value according to the type of bleeding • the automatic volume method (SVE), the average percentage value of the volume difference is 25%. • strongly influenced by slice thickness or reconstructed slices, thinner slice thickness will result in more accurate volume measurements

DISCUSSION

2. The results of the measurement of bleeding volume using **sequence technique** are based on manual and automatic measurement methods

- The principle sequence technique is that the X-ray tube and detector move around the patient and collect data from the first and stop data. Then the patient moves to the second position and the scan takes place on its own. Sequence techniques are often referred to as axial scanning techniques. During scanning the x-ray tube rotates around the patient to produce a specific set of data. To obtain other images, the examination table must move to other positions and data sets to produce CT scan images (Blank, 1998)
- The results of measuring the volume of bleeding in this study using the sequence technique, **the values obtained are close to the actual volume using the manual method**. The results of the different paired samples T Test with a significance value of 5 ml 0.000, 10 ml volume 0.000, 15 ml volume 0.012 and 20 ml volume 0.000 (P-value < 0.05), it can be concluded that there is a significant difference in the technique. sequence using automatic and manual methods.

Sequences techniques, manual vs automatic

Manual	Automatic
• **close to the actual volume using the manual method**	• strongly influenced by **slice thickness** or reconstructed slices, thinner slice thickness will result in more accurate volume measurements

DISCUSSION

3. The value of the standard deviation of the results of the measurement of bleeding volume using **sequence and spiral technique** is compared with the actual volume
   - Based on the measurement results, the spiral technique in the automatic method has a smaller standard deviation value, while **the manual method sequence technique has a smaller standard deviation value**
   - This is in accordance with Siemens (2005) that the Automatic Volume Method (software volume evaluation) is a volume calculation by computer software on the CT Scan tool. This method of volume calculation is used after all parameters and the scanning process is complete. The calculation of bleeding volume based on this method is only used on CT Scans with spiral or helical techniques.

CONCLUSSION

- 1. The results of the spiral technique bleeding volume measurement based on the manual method, the average values that are close to the actual volume are the volumes of 5 ml (4.39 cm3) and 15 ml (11.40 cm3). While the spiral technique of the automatic method is at a volume of 10 ml (8.09 cm3) and 20 ml (18.93 cm3). The results of the different paired samples T Test with a significance value of 5 ml 0.000, 10 ml volume 0.000, 15 ml volume 0.001 and 20 ml volume 0.021 (P-value < 0.05)
- 2. The results of the spiral technique bleeding volume measurement based on the manual measurement method are close to the actual volume. The results of the different paired samples test T Test the significance value at a volume of 5 ml = 0.000, a volume of 10 ml 0.000, a volume of 15 ml = 0.012 and a volume of 20 ml = 0.000 (P-value < 0.05)
- 3. The value of the standard deviation of the measurement of bleeding volume using the sequence technique and the spiral technique compared to the actual volume measured by the spiral technique in the automatic method has a smaller standard deviation value, while the manual sequence technique has a smaller standard deviation value.

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Thank You