

Brain Infarction Volume Through Non-Contrast Head MSCT Scan In Various Plasma Fibrinogen Level

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Abstract

Ischemic stroke occurs due to a blockage of blood vessel flow caused by thrombus. One of elements that plays a crucial role in thrombus formation is fibrinogen. Multiple Slice Computed tomography (MSCT) scan is the main modality in diagnosing stroke. This study aims to evaluate brain infarction volume through non-contrast head MSCT Scan in various plasma fibrinogen level of acute ischemic stroke patient. This was a descriptive study with retrospective design conducted from July 2019 to February 2020 at Dr. Soetomo General Hospital, Surabaya, Indonesia. Sample of this study was ischemic stroke patients who met inclusion criteria. Data regarding plasma fibrinogen level was obtained through medical records. Brain infarction volume was measured using non-contrast head MSCT scan. There were 84 samples in this study. Infarction volume ranges from 1.64—350.35 mL. We divided the infarction volume into three groups: low, medium and high volume. Plasma fibrinogen levels ranges from 88.3 mg/dl to 723.4 mg/dl. The lowest and highest fibrinogen levels were found in low volume group. The highest mean value of fibrinogen levels (362.0 mg / dl) was in medium volume group, while the lowest (310.4 mg/dL) was in low volume group. Cerebral infarction volume through non-contrast head MSCT scan varied from 1.64 mL to 350.35 mL. Fibrinogen levels in acute ischemic stroke patients varied from 88.3 mg/dL to 723.4 mg / dL.

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Keywords: ischemic stroke; non-contrast head CT scan; fibrinogen

1. Background

Stroke prevalence in Indonesia according to Basic Health Research in 2018 is 10.9 per 1000 population. This number is higher compared to 7 per 1000 population in 2013. The highest stroke prevalence was in East Kalimantan at 14.7 per 1000 population and the lowest was in Papua at 4.1 per 1000 population. Stroke prevalence increases with age, where the most prevalent age is ≥ 75 years, compromising 50.2% of stroke prevalence. Stroke occurred slightly more common in men (11.0%) compared to women (10.9%) and occurred more frequently in urban residents (12.6%) compared to rural residents (8.8%) (Health Ministry of Indonesia, 2018).

Stroke is divided into two types based on its pathophysiology: ischemic and haemorrhagic stroke (Ng JL et al., 2011). Ischemic stroke occurs due to a blockage of blood vessel flow. This blockage is caused by a thrombus from plaque that adheres to atherosclerotic blood vessel. One of elements that plays a crucial role in thrombus formation is fibrinogen (Packard RRS et al., 2008). Several studies reported that fibrinogen levels doubled in cardiovascular disease patients, as well as in transient ischemic attack (TIA) or ischemic stroke (Ritarwan K et al., 2017). Computed tomography (CT) scan is the main modality in diagnosing stroke. Therefore, this study aims to evaluate brain infarction volume through non-contrast head MSCT Scan in various plasma fibrinogen level of acute ischemic stroke patient. This study is limited to acute ischemic stroke because hypodense area of brain parenchyma on head Multislice (MS)CT scan is clearly visible 6 hours after stroke attack, whereas in chronic ischemic stroke, hypodense area is almost similar in density to cerebrospinal fluid (CSF) (Johnson W et al., 2016; Catanese L et al., 2017).

2. Methods

2.1. Study design and setting

This was a descriptive study with retrospective design. The time of study was from July 2019 to February 2020 at Dr. Soetomo General Hospital, Surabaya, Indonesia.

2.2. Study population and sampling strategy

Population in this study was acute ischemic stroke patients that came to Dr. Soetomo. Sample of this study was ischemic stroke patients who met inclusion criteria. Inclusion criteria included: first stroke attack, age ≥ 20 years, and stroke onset within the 6th hour – 7th day. Exclusion criteria included: patients with concomitant infection, autoimmune disease, tumour, cancer, and brain trauma during hospital admission, patients with recurrent stroke, and patients with history of statin drug use.

2.3. Data collection

Data regarding plasma fibrinogen level and cofounding factors that might affect brain infarction such as age, history of hypertension, diabetes mellitus (DM), and dyslipidemia were obtained through medical records. Brain infarction volume was measured using non-contrast head MSCT scan using 128 slice Toshiba Aquilion CX 128 CT Scan Machine.

2.4. Data analysis

Data from head MSCT scans in clinical ischemic stroke patients were reviewed using DICOM file reader application by the authors themselves under neuroradiologists supervision that were blinded. And data regarding plasma fibrinogen level was obtained through medical records. The data were analyzed and presented in frequency and proportion (percentage).

2.5. Ethical considerations

Before this study was conducted, we requested ethical clearance from Ethical Committee of Health Research of Medical Faculty of Airlangga University and research permit from Dr. Soetomo General Hospital.

3. Results

There were 84 samples in this study. Infarction volume ranges from 1.64 ml to 350.35 ml. We divided the infarction volume into three groups: low, medium and high with a range of 0—100 ml, 101—200 ml, and 200 ml, respectively. The group with the highest number of patients was low volume group with 74 patients, while the lowest was 3 patients in high volume group, as shown in Table 1.

Table 1. Infarction volume range

Category	Frequency	Percent
Low (0—100 ml)	74	88.1
Medium (101—200 ml)	7	8.3
High (>200 ml)	3	3.6
Total	84	100.0

In this study, plasma fibrinogen levels were variable from 88.3 mg/dl to 723.4 mg/dl, as shown in Table 2. The lowest and highest fibrinogen levels were found in low volume group. The highest mean value of fibrinogen levels (362.0 mg / dl) was in medium volume group, while the lowest (310.4 mg/dL) was in low volume group.

Table 2. Infarction volume range distribution based on fibrinogen level

Infarction volume range	Fibrinogen (mg/dL)		Infarction volume (mL)
	N		
Low (0—100 ml)	N	74	74
	Minimum	88.30	1.64
	Maximum	723.40	89.72
	Mean	310.4662	12.5119
Medium (101—200 ml)	Std. Deviation	127.46146	14.69708
	N	7	7

	Minimum	262.00	124.71
	Maximum	494.50	193.01
	Mean	362.0429	160.3514
	Std. Deviation	91.54898	23.58187
	N	3	3
High (>200 ml)	Minimum	171.50	207.34
	Maximum	312.00	350.35
	Mean	254.1333	268.8300
	Std. Deviation	73.45137	73.57898
	N	84	84
Total	Minimum	88.30	1.64
	Maximum	723.40	350.35
	Mean	312.7524	33.9861
	Std. Deviation	123.93006	64.12427

Table 3 shows that the youngest ischemic stroke patients who underwent MSCT head scan was 28 years and the oldest was 85 years. Distribution of stroke patients based on age group showed that most patients belonged to 40—59 years group (48.8%), however, the percentage of this age group was only slightly larger than the percentage of > 60 years group (45.2%). The smallest percentage was found in 20—39 years group (6%).

The highest mean infarction volume was found in 40—59 years group (42.1 mL), whereas the lowest was found in 20—39 years group (7.6 mL). Mean infarction volume in >60 group was (28.6 mL).

Table 3. Infarction volume distribution based on age group

Age group (years)	Minimum infarction volume (ml)	Maximum infarction volume (ml)	Mean infarction volume (ml)	Std. Deviation infarction volume (ml)	Patients (n)
20—39	3.01	10.76	7.6020	3.55841	5
40—59	1.95	350.35	42.1851	78.45875	41
> 60	1.64	207.34	28.6113	48.67801	38
Total	1.64	350.35	33.9861	64.12427	84

Table 4 shows that there were 64 patients with hypertension history, while the remaining 20 patients did not know if they had previous hypertension or not. Low volume group had the most hypertension patients (57 patients) with mean infarction volume of 11.8 mL. While the group with the least amount of hypertension patients was the high volume group (3 patients) with mean infarction volume value of 268.8 mL.

Table 4. Infarction volume distribution in patients with history of hypertension

Infarction volume range	Patients (n)	Hypertension history		Total
		No	Yes	
Low (0—100 ml)	Patients (n)	17	57	74
	% within infarction volume range	23.0%	77.0%	100.0%
	% within HT	85.0%	89.1%	88.1%
	% of Total	20.2%	67.9%	88.1%
Medium (101—200 ml)	Patients (n)	3	4	7
	% within infarction volume range	42.9%	57.1%	100.0%
	% within HT	15.0%	6.2%	8.3%
	% of Total	3.6%	4.8%	8.3%
High (>200 ml)	Patients (n)	0	3	3
	% within infarction volume range	0.0%	100.0%	100.0%
	% within HT	0.0%	4.7%	3.6%
	% of Total	0.0%	3.6%	3.6%

Table 5 shows that there were 24 patients with diabetes mellitus (DM) history, and the rest (60 patients) did not. Low volume group had the most DM patients (19 patients), with mean infarction volume of 12.5 mL. Furthermore, high volume group had the least DM patients (one patient), with mean infarction volume of 207.3 mL.

Table 5. Infarction volume distribution in patients with history of DM

Infarction volume range	Patients (n)	DM		Total
		No	Yes	
Low (0—100 ml)	Patients (n)	55	19	74
	% within infarction volume range	74.3%	25.7%	100.0%

	% within DM	91.7%	79.2%	88.1%
	% of Total	65.5%	22.6%	88.1%
	Patients (n)	3	4	7
Medium (101—200 ml)	% within infarction volume range	42.9%	57.1%	100.0%
	% within DM	5.0%	16.7%	8.3%
	% of Total	3.6%	4.8%	8.3%
	Patients (n)	2	1	3
High (>200 ml)	% within infarction volume range	66.7%	33.3%	100.0%
	% within DM	3.3%	4.2%	3.6%
	% of Total	2.4%	1.2%	3.6%

Table 6 shows that there were 65 patients with dyslipidemia symptoms, whereas 19 patients did not. Low volume group had the most dyslipidemia patients (57 patients), with mean infarction volume of 12.1 mL. High volume group had the least dyslipidemia patients (two patients), with mean infarction volume of 299.5 mL.

Table 6. Infarction volume distribution in patients with dyslipidemia symptoms

	Infarction volume range	Dyslipidemia		Total
		No	Yes	
	Patients (n)	17	57	74
Low (0—100 ml)	% within infarction volume range	23.0%	77.0%	100.0%
	% within dyslipidemia	89.5%	87.7%	88.1%
	% of Total	20.2%	67.9%	88.1%
	Patients (n)	1	6	7
Medium (101—200 ml)	% within infarction volume range	14.3%	85.7%	100.0%
	% within dyslipidemia	5.3%	9.2%	8.3%
	% of Total	1.2%	7.1%	8.3%
	Patients (n)	1	2	3
High (>200 ml)	% within infarction volume range	33.3%	66.7%	100.0%
	% within dyslipidemia	5.3%	3.1%	3.6%
	% of Total	1.2%	2.4%	3.6%

4. Discussion

In this study infarction volume was variable, the lowest was 1.64 ml and the highest was 350.35 ml. We divided our samples into three groups: low, medium and high volume. Low volume group had the most patients (74 patients) while high volume group had the least patients (three patients). Plasma fibrinogen levels were also variable, the lowest was 88.3 mg/dl and the highest was 723.4 mg/dl. This lowest and highest fibrinogen level were both found in low volume group. The highest mean fibrinogen level was found in medium volume group (362.0 mg/dl), while the lowest mean fibrinogen level was found in high volume group (254.1 mg/dl). Furthermore, increased infarction volume was not in accordance to increased mean fibrinogen level.

This study results were contrary to previous study conducted by Azam *et al* in Pakistan, where a study was conducted to determine the correlation between infarction volume through non-contrast head CT scan and blood fibrinogen level. They found that infarction volume and fibrinogen level were positively correlated (Azam R *et al.*, 2015). Another study from Khandait and Barai in India regarding fibrinogen level in ischemic and haemorrhagic stroke patients found that elevated infarction volume in ischemic stroke patients was in accordance to fibrinogen level and the highest fibrinogen level was found in deceased patients (Khandait V *et al.*, 2018).

The differences in our study results compared to previous studies might be the due to confounding factors including a large age range, and concomitant diseases such as hypertension, DM, dyslipidemia, and liver diseases. Cardio Vascular Disease Risk Factor Two-towns hip Study (CVDFACTS) study that was conducted by Chuang *et al* in Taiwan found that hypertension, DM, and fibrinogen were predictive factors of ischemic stroke incident (Chuang SY *et al.*, 2009).

The highest mean infarction volume (42.1 ml) was found in 40—59 years group, while the lowest (7.6 ml) was found in 20—39 years group. In >60 years group, mean infarction volume was 28.6 ml. A study in 2001 that classified age group based on face shape classified adults into young adult (20—39 years), middle adult (40—59 years), and old adult (60—79 years). This age classification was in accordance to classification by American Heart Association (AHA) in 2015 for stroke patients (American College of Cardiology, 2019). According to this classification, stroke was most prevalent in middle adult group in our study. This result was different to Basic Health Research data in 2018, where they reported the older the age, the more prevalent stroke incidence was. This difference might be due to samples in our study that were selected based on inclusion and

exclusion criteria, while Basic Health Research included all stroke patients in Indonesia (Health Ministry of Indonesia, 2018).

According to 2019 Indonesian Consensus on Hypertension Management, hypertension is diagnosed when systolic pressure ≥ 140 and diastolic pressure ≥ 90 (Lukito AA et al., 2019). In this study, 64 patients had hypertension while 20 patients did not know whether they had previous hypertension or not. Low volume group had the most hypertension patients (57 patients) with mean infarction volume of 11.8 ml, while high volume group had the least hypertension patients (three patients) with mean infarction volume of 268.8 ml.

Diabetes mellitus diagnostic criteria according to 2015 Indonesian Consensus on Diabetes Mellitus Type 2 Management and Prevention were as followed:

1. Fasting plasma glucose ≥ 126 mg/dl. Fasting is a condition where there is no calorie intake for at least 8 hours, or
2. Plasma glucose ≥ 200 mg/dl 2-hours after Oral Glucose Tolerance Test (OGTT) with a glucose load of 75 grams, or
3. Plasma glucose ≥ 200 mg / dl with classic complaints, or
4. HbA1c $\geq 6.5\%$ using standardized methods by National Glycohemoglobin Standardization Program (NGSP) (Soelistijo SA et al., 2015).

In this study, there were 24 patients who had DM, while 60 patients did not. Low volume group had the most DM patients (19 patients) with mean infarction volume of 12.5 ml, while high volume group had the least DM patients (one patient) with mean infarction volume of 207.3 ml.

Dyslipidemia is defined as LDL level >100 mg/dl or HDL <40 mg/dl, or total cholesterol >200 mg/dl, or triglyceride >150 mg/dl (Aman AM et al., 2019). In this study, there were 65 patients who had dyslipidemia symptoms, while 19 patients did not. Low volume group had the most dyslipidemia patients (57 patients) with mean infarction volume of 12.1 ml, while high volume group had the least dyslipidemia patients (two patient) with mean infarction volume of 299.5 ml.

5. Conclusion

Cerebral infarction volume through non-contrast head MSCT scan varied from 1.64 mL to 350.35 mL. Fibrinogen levels in acute ischemic stroke patients varied from 88.3 mg/dL to 723.4 mg / dL. Further studies with larger number of samples are required and studies that eliminate or uniform the confounding variables are also required to obtain more accurate results.

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