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Original Article

CT clot characteristics and success of endovascular thrombectomy in acute anterior circulation ischemic stroke

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Abstract

Background: CT and CT angiography (CTA) have been informative for acute occlusive thrombus. Conflicting results of the thrombus characteristics and endovascular thrombectomy (EVT) revascularization outcome have been debated.

Objective: We aimed to evaluate CT clot characteristics and EVT outcomes in acute ischemic stroke patients.

Materials and Methods: Unenhanced CT and multiphase CTA brain of 59 acute anterior-circulation ischemic stroke patients undergoing EVT from November 2019 to June 2021 were reviewed. The following clot characteristics were assessed: the most proximal clot location, clot length, clot burden score (CBS), distance from the terminal ICA to the most proximal part of the clot (DT), clot heterogeneity, mean clot attenuation, relative mean clot attenuation to contralateral artery, and clot perviousness. The standard deviation (SD) of the measured clot attenuation represented clot heterogeneity. At least mTICI 2b on post-thrombectomy cerebral angiography was considered successful revascularization. Descriptive and analytic statistical analyses were obtained with $p<0.05$ considered significant.

Results: Fifty two of 59 cases (88.1%) had successful thrombectomy. DT was significantly shorter in the successful group (8.5±9.1 mm) versus the unsuccessful group (16.4±13.2 mm) with p=0.046; however, association between DT and revascularization outcomes did not reach statistical significance (OR=0.94; 95%CI=0.87-1.00; p=0.061). Clot heterogeneity and other characteristics showed no differences between two groups or associations with outcomes.

Conclusion: Among the clot features on unenhanced CT and multi-phase CTA brain in our study group, distance of the clot from terminal ICA (DT) was significantly shorter in the successful EVT group. Further assessment of clot characteristics and EVT outcome in larger numbers of cases should be sought for a potential predictor of success.

Keywords: Acute ischemic stroke, Clot characteristics, Endovascular thrombectomy.

Introduction

Acute ischemic stroke is one of the leading causes of the disabilities across the world. An endovascular treatment has become more recognized and well-established for its benefits in this decade and included in the standard treatment of patients [1]. Identification of imaging biomarkers that predict the endovascular treatment outcome would be beneficial in acute stroke management. Thrombus characteristics on CT and CT angiography (CTA) have been studied for their association with the outcome of acute ischemic stroke, but there are conflicting results [2-7]. Using multi-phase CTA proves more advantageous than over single-phase CTA in evaluation of large vessel occlusion and collateral assessment in acute ischemic stroke. It improves the vessel occlusion detection rate, yearning higher interrater reliability, improves the measurement of clot length, and also assesses clot perviousness [8, 9]. This study aimed to assess whether the clot characteristics on unenhanced CT and multi-phase CTA brain are associated with the mechanical thrombectomy outcome in patients with acute anterior circulation ischemic stroke.

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Materials and methods

Patients

This retrospective study was approved by the Institutional Review Board, and the requirement for informed consent was waived. We included all acute anterior circulation ischemic stroke patients who underwent endovascular thrombectomy at King Chulalongkorn Memorial Hospital from November 2019 to June 2021. The exclusion criteria were the following: 1) less than 18 years of age; 2) clot location occupying the petrous to clinoid segment of the internal carotid artery (ICA); 3) clot with an adjacent calcified plaque; 4) spontaneous resolution or failed endovascular thrombectomy due to markedly tortuous vessels; 5) an undetermined proximal or distal end of the clot; and 6) poor image quality.

Imaging protocol

All patients underwent a CT scan using the 256-slice CT scanner, Revolution™ CT (GE Healthcare, USA) with the following parameters: tube voltage 120 kV, automatically adjusted tube current ranging from 350-600 mA and rotation time of 0.5 second.

All acute ischemic stroke patients were continuously investigated following hospital protocols, including CT brain and multiphase CT angiography (CTA) of the brain and neck, before endovascular thrombectomy. The non-contrast CT brain covered the entire brain and was reconstructed in 1.25-mm thickness in the axial plane and multiplanar reconstruction in 5-mm thickness. Bolus contrast media injection was done using 65 mL of iohexol (350 mgI/mL). The CTA of brain and neck was done using the bolus tracking technique with 8-second intervals in 3 phases: arterial, first delayed, and second delayed. The arterial and second delayed phases covered from the vertex to the aortic arch, and the first delayed phase covered the entire brain. The CTA brain study was reconstructed in an 8-mm maximal intensity projection (MIP) image in axial view for all three phases and with additional sagittal and coronal views for the arterial phase.

Data collection and analysis

The demographic data of the patients were reviewed from the electronic medical records and included the following information: age, sex, underlying disease, the presence of the anti-platelet and the anti-coagulation treatment, the intravenous thrombolytic treatment, The National Institutes of Health Stroke Scale (NIHSS), stroke etiology according to TOAST classification, the hematocrit level, and time of onset or time of last seen normal in the case of an unclear onset. The patients with incomplete evaluation of stroke etiology were counted as strokes with undetermined sources.

The clot characteristics on CT and CTA studies were independently assessed by a radiologist with one year of experience in neuroradiology and a neuroradiologist with eight years of experiences. The two radiologists went through image analyses for five random cases altogether per the following protocols (Figure 1).

Location and length: The location and length were primarily considered on the source image and the MIP image of the multi-phase CTA study, respectively. The most proximal part of the clot was collected as the location of the clot. In unclear circumstances, non-contrast CT and cerebral angiography studies were used to aid in determining the location. A consensus was reached in the selection of the clot location for further analysis in case of dissimilar results. Multi-planar reconstruction in the plane parallel to the arterial course was done to measure the clot length. For clots extending into more than one arterial branch, the longest length in one branch was determined as the clot length.

Clot burden score (CBS): The CBS is a scoring system used to define the extension of an anterior-circulation clot, scaling from 0 to 10 [6]. A score of 2 was subtracted if thrombus was found in each of the supraclinoid ICAs, the proximal, and the distal half of the M1 segment of the MCA. A score of 1 was subtracted if thrombus was found in each of the infraclinoid ICA, ACA, and each M2 branch.

Attenuation and heterogeneity: Three regions of interest (ROIs), each with an area of about 2 mm^2, were placed within the proximal, middle, and distal portions of the clot on an axial 1.25-mm-thickness non-contrast CT study. The average attenuation and standard deviation of these three ROIs were considered the absolute attenuation and the clot heterogeneity, respectively. The other three ROIs were placed within the contralateral artery, symmetrically. The ratio of the average attenuation of the clot to average attenuation of the contralateral artery was the relative attenuation. In the case of a short clot, one or two ROIs were considered appropriate.

Perviousness: Three ROIs were placed within the clots on the source image of the three phases of the CTA study with the same location of ROIs placed on non-contrast CT. Clot perviousness was considered the maximal average attenuation of the clot among the three phases of CTA subtracted by the absolute attenuation of the clot.

Distance from terminal ICA (DT): This distance was considered on MIP images of the CTA study, measuring from the terminal ICA to the most proximal part of the clot. If the clot location was proximal to the terminal ICA, the distance was considered 0.

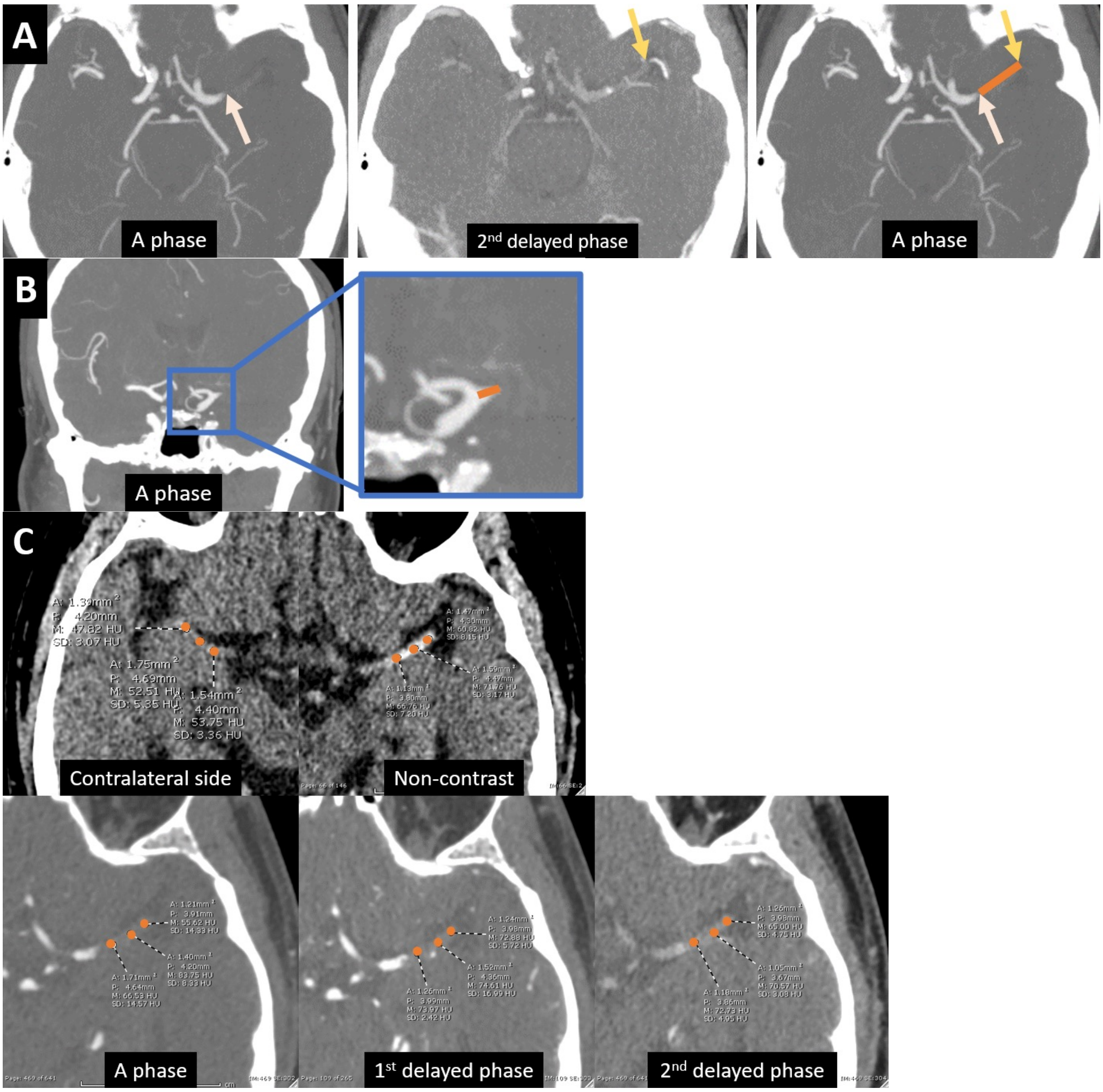

Figure 1. *Imaging analysis and ROI placement; (A, B) The clot length (orange line on Figure A), the location (pale orange arrow on Figure A) and DT (orange line on Figure B) were considered on the CTA MIP image. (C) Attenuation and heterogeneity of the clot acquiring from the three ROIs (orange dots) placed along the clot on all phases as well as the contralateral side on the non-contrast image.*

The degree of revascularization was assessed from the digital subtraction cerebral angiography study and graded by a neurointerventionist with five years of experiences using modified thrombolysis in the cerebral infarction (mTICI) score with the grade of at least mTICI 2b considered as successful revascularization [10]. The following additional information regarding the operation was collected: the puncture time, the reperfusion time, the method of thrombectomy (aspiration or stent retriever), the number of attempts, and immediate complications.

Statistical analysis

The baseline characteristics and thrombectomy data were calculated using frequency and percentage or the mean and standard deviation. In the case of categorical data, the Pearson Chi-Square Fisher's Exact tests were used. For numerical data, the student-t test was used. The logistic regression analysis was used to test the association between CT characteristics and success of the thrombectomy. The interobserver reliability was calculated using kappa statistics for categorical data and intraclass correlation for numerical data. A p-value less than 0.05 was considered statistically significantly different. Based on the precision of the 95%CI around the prevalence, the estimated sample size should be 120. All statistical analyses were performed using SPSS statistical software version 22.

Results

We collected 90 cases of acute anterior-circulation ischemic stroke undergoing endovascular thrombectomy during the mentioned period. We excluded 16 cases of clot locations occupying the petrous to the clinoid segment of ICA, 3 cases of spontaneous resolution, 1 case of failed treatment due to tortuous vessels, 6 cases of an undetermined exact clot location, and 5 cases of inadequate image quality. Finally, we reviewed 59 patients, consisting of 52 successful cases (88.1%), and 7 unsuccessful cases (11.9%).

Baseline data

The mean age and range were 65 years (range 25-89 years) in the successful group and 61 years (range 31-85 years) in the unsuccessful group. In both groups, there was a slight predominance of females, which was 63.5% in the successful group and 57.1% in the unsuccessful group. There was no significant difference in the underlying diseases, ongoing medications, intravenous thrombolytics, the hematocrit level, and NIHSS between two groups. Nonetheless, we found a significantly shorter period from last-seen-normal to puncture time in the successful group (6.8±4.6 hours versus 13±7.7 hours, p=0.003). The most common stroke etiology was a cardioembolic cause for both groups. There was one case of a methamphetamine-related cause. The data was summarized in Table 1.

Table 1. *Baseline data in successful and unsuccessful groups (age shown in mean (range); onset-to-puncture period and NIHSS shown in mean (SD); other parameters shown in n (percentage)).*

	Successful group (n=52)	Unsuccessful group (n=7)	P value
Age (year)	65 (25-89)	61 (31-85)	0.518
Sex (male/total)	19/52 (36.5%)	3/7 (42.9%)	1.000
Underlying disease			
Diabetes	10/52 (19.2%)	3/7 (42.9%)	0.173
Hypertension	20/52 (38.5%)	2/7 (28.6%)	0.702
Dyslipidemia	17/52 (32.7%)	2/7 (28.6%)	1.000
Previous ischemic stroke	9/52 (17.3%)	1/7 (14.3%)	1.000
Ischemic heart disease	8/52 (15.4%)	1/7 (14.3%)	1.000
Atrial fibrillation	22/52 (42.3%)	3/7 (42.9%)	1.000
Ongoing anti-platelet therapy	8/52 (15.4%)	0	0.578
Ongoing anticoagulant therapy	18/52 (34.6%)	2/7 (28.6%)	1.000
Intravenous thrombolytics	27/52 (51.9%)	2/7 (33.3%)	0.670
Last seen normal – puncture (hour)	6.8 (4.6)	13.0 (7.7)	0.003
Hematocrit	37.5 (5.5)	37.8 (6.2)	0.900
NIHSS	17.4 (4.8)	14.7 (3.5)	0.184
TOAST classification			
Cardioembolism	32/52 (61.5%)	4/7 (57.1%)	
Large vessel disease	3/52 (5.8%)	2/7 (28.6%)	
Indetermined source	17/52 (32.7%)	0	
Others	0	1/7 (14.3%)	

Thrombectomy-related data

The successful group consisted of 45 cases of mTICI 2b and 7 cases of mTICI 3, as shown in Table 2. The unsuccessful group consisted of 1 case of mTICI 0, 2 cases of mTICI 1, and 4 cases of mTICI 2a. There were 37 cases with first-pass success (62.7%).

The number of patients treated with aspiration-only, stent retriever-only, and combined methods were 47 cases, 6 cases, and 6 cases, respectively (p=0.438). Forty six of 53 patients (86.7%) were treated with aspiration thrombectomy using a 6F catheter, while 6 patients (11.3%) using a 5F catheter, and 1 patient (1.8%) using a 6.5F catheter. Patients underwent stent-retriever thrombectomy using various sizes of stents including 3x20 mm, 4x15 mm, 4x20 mm, 4x40 mm, 6x40 mm. The 4x20 mm stent was predominantly used (8/12 patients, 66.7%). The mean and SD of the number of attempts of the successful and unsuccessful groups were 1.5±1.0 times and 2.3±1.0 times, respectively (p=0.052). The mean procedure duration was 28.4 minutes in the successful group and 40.6 minutes in the unsuccessful group (p=0.488). There were 5 cases and 2 cases where immediate complications were developed in both groups, respectively (p=0.190). These complications were distal embolization and dissection.

Table 2. *Thrombectomy-related data (operating time shown in mean (SD); other parameters shown in n (percentage)).*

	Successful result (n=52)	Unsuccessful result (n=7)	P value
mTICI score			
0	-	1/7 (14.3%)	
1	-	2/7 (28.6%)	
2a	-	4/7 (57.1%)	
2b	45/52 (86.5%)	-	
3	7/52 (13.5%)	-	
First-pass success	37/52 (71.2%)	-	
Method			0.438
Aspiration only	42/52 (80.8%)	5/7 (71.4%)	
Stent retriever only	5/52 (9.6%)	1/7 (14.3%)	
Combined	5/52 (9.6%)	1/7 (14.3%)	
Operating time (minute)	28.4 (15.3)	40.6 (43.3)	0.488
Complication	5/52 (9.6%)	2/7 (28.6%)	0.190

CT clot characteristics and association with outcomes

There was no significant difference in the clot location between the successful and unsuccessful groups (p=0.066). The most common location was M1 segment of the MCA in the successful group (34/52 patients, 65.4%) and M2 segment of the MCA in the unsuccessful group (4/7 patients, 57.1%). There were 8 cases and 1 case of a supraclinoid ICA-located clot in the successful and unsuccessful groups, respectively. There was no clot location in A1 or A2 segments of the ACA. The mean and SD of the CBS and clot length in the successful group were 3.2±1.7 and 13.7±7.0 mm, slightly higher than those of the unsuccessful group (2.3±2.2 and 10.0±6.4 mm). The mean DT of the unsuccessful group was 16.4 mm, which was significantly longer than the mean of 8.5 mm in the successful group (p=0.046).

However, there was no statistically significant association between the DT and the successful outcome (p=0.061). The absolute attenuation (56.1±8.9 HUs versus 56.3±10.7 HUs), relative attenuation (1.3±0.3 versus 1.4±0.4), heterogeneity (5.5±1.0 HUs versus 5.9±1.5 HUs), and perviousness (9.8±12.8 HUs versus 8.1±15.5 HUs) between the two groups showed no statistically significant difference. There was no significant association between the clot location, parameters, and successful outcomes. Table 3 summarizes overall clot characteristics between the successful and unsuccessful groups and Table 4 shows the binary logistic regression of the CT clot characteristics and the successful outcome.

Table 3. *CT clot characteristics and success of thrombectomy (location data shown in n (percentage); other parameters shown in mean (SD)).*

	Successful result (n=52)	Unsuccessful result (n=7)	P value
Location			0.066
Supraclinoid ICA	8/52 (15.4%)	1/7 (14.3%)	
M1 MCA	34/52 (65.4%)	2/7 (28.6%)	
proximal M1	17/52 (32.7%)	0	
distal M1	17/52 (32.7%)	2/7 (28.6%)	
M2 MCA	10/52 (19.2%)	4/7 (57.1%)	
Clot burden score	3.2 (1.7)	2.3 (2.2)	0.197
Length (mm)	13.7 (7.0)	10.0 (6.4)	0.190
Distance from terminal ICA (mm)	8.5 (9.1)	16.4 (13.2)	0.046
Absolute attenuation (HU)	56.1 (8.9)	56.3 (10.7)	0.967
Heterogeneity (HU)	5.5 (1.0)	5.9 (1.5)	0.451
Relative attenuation	1.3 (0.3)	1.4 (0.4)	0.405
Perviousness (HU)	9.8 (12.8)	8.1 (15.5)	0.755

Table 4. *Binary logistic regression analysis between CT clot characteristics and success of thrombectomy.*

	OR	95% CI	P-value
Location			
Supraclinoid ICA	1 (reference)		
M1 MCA	2.13	0.17-26.44	0.558
M2 MCA	0.31	0.03-3.38	0.338
Clot burden score	1.43	0.82-2.48	0.204
Length	1.11	0.95-1.29	0.199
Distance from terminal ICA	0.94	0.87-1.00	0.061
Absolute attenuation	1.00	0.91-1.09	0.966
Heterogeneity	0.71	0.34-1.46	0.349
Relative attenuation	0.34	0.03-4.23	0.401
Perviousness	1.01	0.95-1.08	0.750

Furthermore, we determined if the patients had the hyperdense vessel sign which was considered positive when the relative attenuation was ≥1.16 [4]. There were 41 positive cases (78.8%) in the successful group and 5 positive cases (71.4%) in the unsuccessful group (p=0.643). The ratio of clot attenuation and the hematocrit level of each patient was calculated. The mean and SD of this ratio was 1.5±0.3 in the successful group and 1.5±0.4 in the unsuccessful group (p=0.897).

There was no significant association between the CT clot characteristics and the immediate complication.

Interobserver reliability

We achieved an excellent agreement in location determination with the Kappa coefficient of 0.93. The Kappa coefficients of each segment involvement of the supraclinoid ICA, proximal M1 segment, distal M1 segment, M2 segment, A1 segment, and A2 segment were 1.00, 0.90, 0.78, 0.56, 0.81, and 1.00, respectively. The intra-class correlation coefficient (ICC) for CBS was 0.93. The ICCs for the clot length and DT were 0.94, and 0.95, respectively. The ICCs for the attenuation ranged from 0.54 to 0.83. The ICC for the heterogeneity was 0.46.

Discussion

According to the TOAST classification, there were 36 cases (61.0%) of the cardioembolic cause, 5 cases (8.5%) of large vessel atherosclerosis, 17 cases (28.8%) of an undetermined cause and 1 case of the methamphetamine-related cause. Roessler et al showed 44% of their cases having the cardioembolic cause, followed by 24.8% of undetermined etiology and 21.6% of large vessel atherosclerosis [11]. However, Boodt et al showed 49.8% of undetermined etiology as the most common type, followed by 33% of cardioembolism and 13% of large vessel atherosclerosis [12]. Although compared with cardioembolism, large artery atherosclerosis was generally more prevalent in the Asian population [13], our study showed a low proportion of the large vessel atherosclerosis. This might be because we included only thrombectomy cases and unintentionally excluded the majority of this type of stroke.

Our study consisted was of 59 cases of acute anterior circulation ischemic stroke patients undergoing endovascular thrombectomy with 52 successful cases (88.1%). Other studies showed similar success rates with 84.6% from the Byun study [3] and 86.0% from the MR CLEAN registry [4].

Most of our cases underwent aspiration thrombectomy as the primary method upon the preference of the interventionists with 47 cases (79.7%) undergoing the aspiration-only method. Although many previous studies used the stent retriever method as a primary method with an overall success rate of 86.0-89.2% [4,5], our study showed a success rate comparable to theirs. Moreover, Mokin et al showed no significant difference in the thrombectomy outcome between aspiration first group (93.8%) and stent retriever first group (91.6%) [5]. Schartz et al. meta-regression analysis study revealed a significant association between the increasing aspiration catheter internal diameter and the first pass effect, and between the internal diameter and the final recanalization. Our cases were treated with aspiration thrombectomy, and nearly uniform catheter size (6F catheter, 86.7%) was used in the combined methods. The influence of the aspiration catheter diameter was not exhibited in our study [14].

Despite the existence of many studies, there have been differing results on whether CT clot characteristics could predict reperfusion after endovascular thrombectomy. Extensive studies about the clot composition have been conducted giving the enlightenment of the wide range of various clot components and their proportions as well as their clinical relevance [15-18]. Some studies showed a significant association between the hyperdense artery sign and the RBC content of the clot [17, 19]. Gunning et al found that the clot with more RBC content had lower friction coefficient [20]. Furthermore, there were some studies showing a higher success rate in the patients with a higher-density clot [5, 21]. However, several studies with larger numbers of patients showed no association between the clot density and the successful outcome [2, 4, 22, 23]. In our study, there was no significant association between the clot attenuation and the successful thrombectomy. We weighed the clot attenuation with the contralateral artery attenuation and the hematocrit level as well as categorized patients with the hyperdense vessel sign. Still, we found no association of these corrected/modified attenuation parameters and the outcome. Therefore, our study supported the result of the majority.

The clot compositions are typically a mixture of fibrin, platelets, white blood cells and red blood cells (RBC) resulting in clot heterogeneity. Increased RBC content is proposed associated with vulnerability to treatment with intravenous thrombolysis or mechanical thrombectomy. While an increased fibrin or platelet content is supposed to be associated with resistance to treatment. The platelet-rich areas contain dense fibrin, von Willebrand factor (vWF), abundant leukocytes and extracellular DNA, which are potentially responsible for resistance to thrombolysis and thrombectomy [24, 25]. Liu et al found that more spatial heterogeneity of the clot on the histology was associated with less first-pass success, which was assumed to be due to the higher fragility [26]. To the best of our knowledge, there is no published study demonstrating the association between the radiologic clot heterogeneity and the outcome of thrombectomy. We gathered the average of the SD of the attenuation of the clot which we believed would represent the heterogeneity of the clot composition. Our results showed no significant difference in the SD between two groups. The important drawback was that the SD value of the clot was highly spatially variable, and we did not place more than three ROIs on the clot regardless of the clot length. The long-length clots went through under-sampling. This could be the main source of the relatively low interobserver reliability among all CT parameters. Hence, further studies should give insights on this issue with an entire clot length analysis, and the correlation between radiologic heterogeneity and histologic heterogeneity should be sought out.

There has been conflicting data regarding the clot perviousness and the thrombectomy outcome. Mokin et al dichotomized the patients and found that the high perviousness group had been associated with higher rates of first-pass success in the aspiration first group but not in the stent retriever first group [22]. In addition, Benson's study showed that higher perviousness had been associated with higher RBC density and lower fibrin density, which could provide the possible explanation of higher first-pass success in the more pervious clot [27]. In contrast, Patel et al showed a positive correlation between the perviousness and the percent of fibrin/platelet aggregates [16]. They also showed a negative correlation between the perviousness and the first-pass success, but there was no statistical significance ($p=0.055$). Our results showed no significant association between perviousness and the successful outcome as well as Dutra et al results [4]. We believe that this inconclusive result might be associated with the number of factors contributing to the measured clot perviousness, not only because of the proportion of the clot composition but also its distribution and density as well as the hemodynamic status of the patient, the imaging protocol, and measurement methods.

Aside from the clot composition, clot location, clot length and DT have also been studied for a decade. We demonstrated significant differences between the DT of the two groups (p=0.046), but no significant association with the thrombectomy outcome (p=0.061). A few studies showed that DT could potentially predict the thrombectomy outcome in the case of M1 occlusion since they found that shorter DT was associated with more success rate [28, 29]. However, Dutra et al found no association between the DT and the thrombectomy outcomes regardless of the location [4].

Sujijantara et al conducted a meta-analysis of the impact of the clot location after thrombectomy and found no difference in recanalization success by the clot location [7]. However, there was a large study showing a significant association between proximal and distal M1 locations and successful reperfusion [4]. In our study, there were 2 unsuccessful cases (5.6%) among all 36 cases of M1-located clots, while there were 4 unsuccessful cases (28.6%) among 14 cases of M2-located clots. This result might be concordantly related to the shorter DT in the successful group. Despite the apparently different proportions, our result demonstrated no significant association between the location and the successful outcome. Further studies with a greater number of cases would help clarify this inconclusive association among the location, DT, and the thrombectomy outcome.

According to our result, the clot length showed no association with the successful outcome. A few studies also found no association between the clot length and the thrombectomy outcome whether using a stent retriever or an aspiration method [4, 30, 31]. Guenego et al found the association between the angulated or the bifurcated clot shape in M1 segment detected by T2*WI MRI and a poorer thrombectomy outcome [32]. Further studies of the CT clot shape might find a significant association.

Mokin et al performed a subgroup analysis of the SWIFT PRIME study and classified acute ischemic stroke patients into three groups, according to CBS from single phase CTA. They found indifferent high rates of reperfusion in all three groups using the stent retrieve method (86.2%-100%) [5]. Other studies including ours shared the same result [4]. In addition, we acquired CBS from the multiphase CTA, which could dissolve their limitation of clot extension overestimation to some degree.

Knowledge about the clot composition and its association with imaging findings are supposed to influence the treatment outcome. Our study showed unenhanced CT and multi-phase CTA brain were reliable non-invasive imaging methods and should be used for assessment of the occlusive thrombus in acute ischemic stroke. A shorter distance of the clot from the terminal ICA was found in successful thrombectomy patients than unsuccessful patients in our study.

We noticed a few limitations in our study. First, there was a small and inadequate number of patients, particularly the unsuccessful patients. Therefore, there would be insufficient statistical power and a statistically nonsignificant result. Second, this study was conducted in a single tertiary care center, inevitably resulting in the selection bias. Third, all the ROIs were placed manually on all phases of images without co-registration software. However, the majority of the interobserver reliability was satisfactory. Lastly, the numerical data from the ROI did not represent the whole clot length. This might mainly influence the clot with heterogeneous composition along its length. The novel imaging techniques and availability of the co-registration software will also provide more reliable results. In addition, further studies with greater numbers of cases are needed to confirm our results.

Conclusion

Our study found the distance of the clot from the terminal ICA was shorter in the successful thrombectomy cases. There was no association between other CT clot characteristics on non-contrast CT and multi-phase CTA and the endovascular thrombectomy outcome in acute anterior circulation ischemic stroke.

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