Original Article

Subarachnoid Hemorrhage: The Incidence and Correlation of CT Pattern and the Location of Cerebral Aneurysm

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Background: Subarachnoid hemorrhage has a high mortality and morbidity rates, and the cerebral aneurysm is the most common cause. The location of the ruptured cerebral aneurysm is diagnosed by cerebral angiogram and by computed tomography (CT) pattern of the subarachnoid hemorrhage.

Objective: To find the incidence of CT pattern of each cerebral aneurysm and the correlation between CT pattern of subarachnoid hemorrhage and each location of cerebral aneurysm.

Materials and Methods: The 126 patients with ruptured cerebral aneurysm were included in the present study. The information of the patients and CT were recorded and analyzed.

Results: There were 49 male and 77 female patients. The highest location of cerebral aneurysm is anterior communicating aneurysm (59 patients, 47.6%). There were correlations between A region and anterior cerebral and anterior communicating aneurysm, and left D legion and the other location aneurysm. There were correlations between intracerebral hemorrhage and anterior communication, posterior communication cerebral, and anterior cerebral and middle cerebral artery aneurysm.

Conclusion: The common location of cerebral aneurysm is anterior communicating artery aneurysm. There are correlations between the most thickness region of A and D region with anterior communicating aneurysm and the posterior circulation aneurysm, and the correlation between intracerebral hemorrhage and anterior communicating aneurysm, posterior communicating aneurysm, and middle cerebral artery aneurysm.

Keywords: Subarachnoid hemorrhage, Cerebral aneurysm, Intracerebral hemorrhage, Thickness

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Subarachnoid hemorrhage (SAH) is a type of cerebrovascular disease that accounts for about 3% of strokes(1). The morbidity and mortality rates from ruptured cerebral aneurysms are about 50%(2), and while there are many causes for this condition, including arteriovenous malformation (AVM), brain tumor, and trauma, the most common reason for spontaneous SAH is cerebral aneurysm, which is the underlying cause in about 87% of cases(2). Multiple aneurysms constitute one of the most challenging problems for surgeons, and account for approximately 12% to 45% of all cerebral aneurysms(3). Diagnosis of which aneurysm is the cause of bleeding is very important, and even the neurosurgeon's view will be liable to some errors of judgment on which aneurysm was the cause of SAH. Cerebral angiogram is currently used in diagnosis. Another regularly-employed tool is computed tomography (CT) pattern of SAH, but this is still a controversial modality because some studies have reported a correlation of as high as 85% while others relate only about 10%(4,5).

The objectives of the present research were 1) to determine the incidence of CT pattern of each cerebral aneurysm, and 2) to establish the correlation between CT pattern of SAH and location of cerebral aneurysm.

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Materials and Methods

The study protocol was reviewed and approved by the Ethics Committee of Rajavithi Hospital (No.092/2562). Between January 1989 and December 2018, 126 consecutive patients with signs and symptoms of aneurysmal SAH were admitted to the neurosurgical unit of Rajavithi Hospital. Their diagnoses were confirmed by CT on admission, and

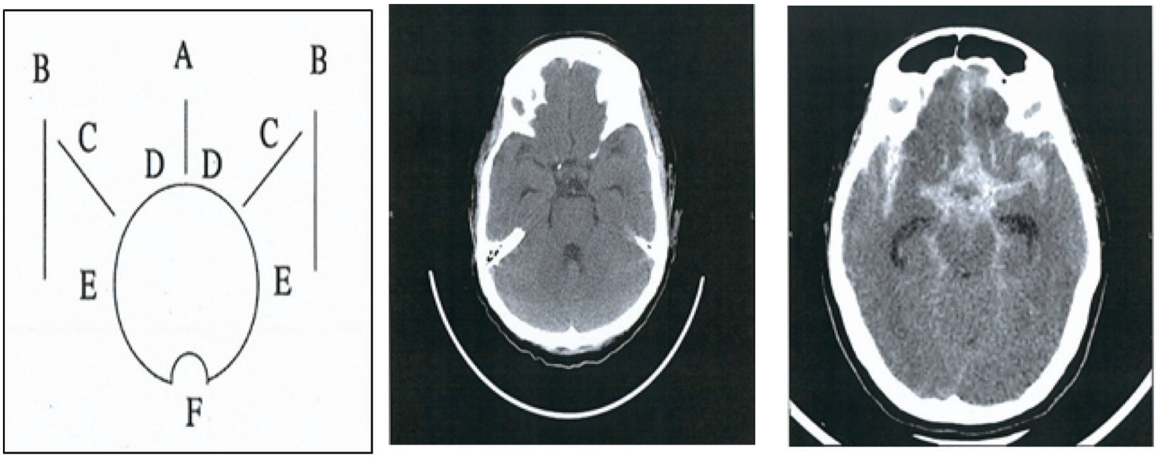

Figure 1. Division of subarachnoid spaces into 10 different basal cisterns and fissures according to the classification of Hijdra[6].

all underwent operations in the hospital. Information regarding the patients' age, location of intracerebral hemorrhage, and location of cerebral aneurysm were recorded, together with data from CT about SAH thickness (as in Figure 1), and about intracerebral hemorrhage.

The widest SAH in each subarachnoid space was recorded together with the location of the cerebral aneurysm from CT and operative notes. The precise location of the ruptured aneurysm was designated as follows, ICA and Pcom=internal carotid artery and posterior communicating cerebral artery aneurysm, A2=anterior cerebral artery, MCA=middle cerebral artery, Acom=anterior communicating artery, other=other location of cerebral artery aneurysm, and no=no cerebral artery aneurysm. All patients underwent operations to determine the site of the ruptured aneurysm.

Statistical analysis

Data analyses were performed using IBM SPSS Statistics software, version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as number (percentage) and median (min-max). Kruskal-Wallis test with the Monte Carlo method was used to find the correlation between the location of the ruptured cerebral aneurysm and that of subarachnoid and intracerebral hemorrhaging.

Results

One hundred twenty-six patients were included in the present study. Of these, 61.11% were female. The highest frequency of cerebral aneurysm was Acom aneurysm (47.60). The most common location of intracerebral hemorrhage was rectus gyrus and temporal hematoma, respectively (shown in Table 1).

Table 1. Demographic data (n=126)

Factors	n (%)
Sex	
Male	49 (38.8)
Female	77 (61.1)
Location	
Acom	59 (47.6)
ICA	30 (24.2)
MCA	27 (21.8)
ACA	5 (4.0)
No	2 (1.6)
Other	1 (0.8)
Intracerebral Hemorrhage	
No	76 (60.3)
Rectus gyrus	18 (14.3)
Temporal hematoma	10 (7.9)
Frontal hematoma	9 (7.1)
Septum pellucidum	7 (5.6)
Corpus collosum	5 (4.0)
Subdural hematoma	1 (0.8)

Acom=anterior communicating artery; ICA=internal carotid artery; MCA=middle cerebral artery; ACA=anterior cerebral artery

The correlation between location of SAH and cerebral aneurysm found that A location was correlated with Acom and A2 cerebral aneurysm, and left D was correlated with other locations of cerebral aneurysm such as in the posterior location (shown in Table 2, Figure 2, 3).

The association between intracerebral hemorrhage and location of cerebral aneurysm is shown in Table 3.

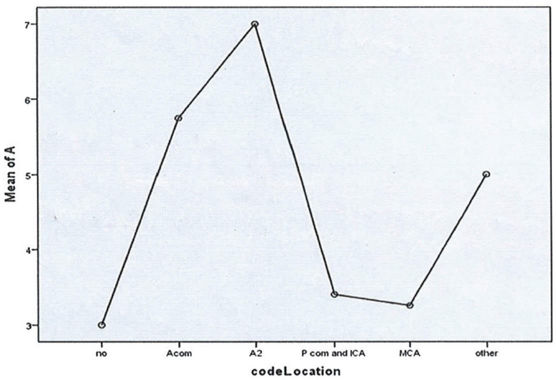

Figure 2. The correlation of A location and the cerebral aneurysm.

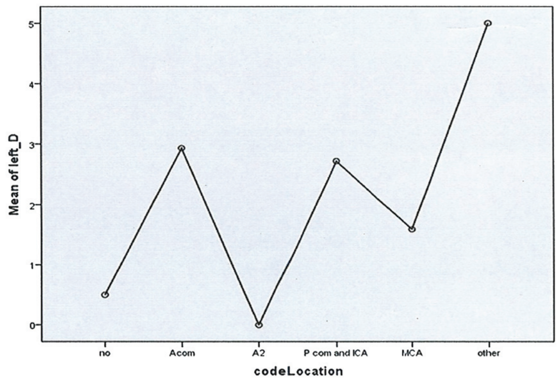

Figure 3. The correlation of D position and the cerebral aneurysm.

Table 2. Association between location of ruptured cerebral aneurysm and location of the thickest blood in subarachnoid space

Location of the thickest blood in subarachnoid space	Location of aneurysm; median (min-max)						p-value
	No	Acom	A2	Pcom and ICA	MCA	Other	
A	3.0 (0.0 to 6.0)	6.0 (0.0 to 16.0)	6.0 (6.0 to 9.0)	4.0 (0.0 to 9.0)	0.0 (0.0 to 11.0)	5.0 (5.0 to 5.0)	0.008*
Left_B	4.0 (0.0 to 8.0)	5.0 (0.0 to 10.0)	0.0 (0.0 to 0.0)	4.5 (0.0 to 14.0)	1.0 (0.0 to 8.0)	5.0 (5.0 to 5.0)	0.091
Right_B	5.0 (0.0 to 10.0)	1.0 (0.0 to 9.0)	8.0 (0.0 to 8.0)	4.0 (0.0 to 10.0)	3.0 (0.0 to 14.0)	8.0 (8.0 to 8.0)	0.833
Right_C	3.5 (0.0 to 7.0)	1.0 (0.0 to 8.0)	5.0 (0.0 to 5.0)	4.0 (0.0 to 10.0)	4.0 (0.0 to 11.0)	6.0 (6.0 to 6.0)	0.173
Left_C	0.5 (0.0 to 1.0)	4.0 (0.0 to 13.0)	5.0 (5.0 to 5.0)	4.0 (0.0 to 10.0)	0.0 (0.0 to 7.0)	5.0 (5.0 to 5.0)	0.099
Left_D	0.5 (0.0 to 1.0)	3.0 (0.0 to 13.0)	0.0 (0.0 to 0.0)	3.0 (0.0 to 7.0)	0.0 (0.0 to 6.0)	5.0 (5.0 to 5.0)	0.038*
Right_D	0.5 (0.0 to 1.0)	2.0 (0.0 to 12.0)	0.0 (0.0 to 0.0)	1.0 (0.0 to 11.0)	1.0 (0.0 to 8.0)	6.0 (6.0 to 6.0)	0.147
Left_E	0.5 (0.0 to 1.0)	1.0 (0.0 to 46.0)	0.0 (0.0 to 0.0)	1.0 (0.0 to 17.0)	0.0 (0.0 to 9.0)	7.0 (7.0 to 7.0)	0.099
Right_E	0.5 (0.0 to 1.0)	1.0 (0.0 to 12.0)	6.0 (0.0 to 6.0)	1.5 (0.0 to 15.0)	4.0 (0.0 to 13.0)	6.0 (6.0 to 6.0)	0.334
F	3.5 (0.0 to 7.0)	0.0 (0.0 to 13.0)	0.0 (0.0 to 0.0)	1.0 (0.0 to 9.0)	0.0 (0.0 to 8.0)	3.0 (3.0 to 3.0)	0.370

No=no cerebral artery aneurysm; Acom=anterior communicating artery; A2=anterior cerebral artery; Pcom and ICA= posterior communicating cerebral artery aneurysm and internal carotid artery; MCA=middle cerebral artery; Other=other location of cerebral artery aneurysm

* Significant as p-value less than 0.05 with Kruskal-Wallis test

Table 3. Association between intracerebral hemorrhage and location of cerebral aneurysm

	Location of aneurysm; n (%)						p-value
	No	Acom	A2	Pcom and ICA	MCA	Other	
Intracerebral hemorrhage							<0.001*
No	2 (2.7)	29 (38.7)	0 (0.0)	27 (36.0)	2 (2.7)	2 (2.7)	
Rectus gyrus	0 (0.0)	17 (94.4)	1 (5.6)	0 (0.0)	0 (0.0)	0 (0.0)	
Temporal hemorrhage	0 (0.0)	0 (0.0)	0 (0.0)	3 (33.3)	6 (66.7)	0 (0.0)	
Frontal hemorrhage	0 (0.0)	5 (55.6)	0 (0.0)	0 (0.0)	4 (44.4)	0 (0.0)	
Septum pellucidum	0 (0.0)	6 (85.7)	0 (0.0)	1 (14.3)	0 (0.0)	0 (0.0)	
Corpus collosum	0 (0.0)	2 (40.0)	2 (40.0)	1 (20.0)	0 (0.0)	0 (0.0)	
Subdural hematoma	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)	

No=no cerebral artery aneurysm; Acom=anterior communicating artery; A2=anterior cerebral artery; Pcom and ICA= posterior communicating cerebral artery aneurysm and internal carotid artery; MCA=middle cerebral artery; Other=other location of cerebral artery aneurysm

* Significant as p-value less than 0.05 with Monte Carlo method

Rectus gyrus was associated with Acom aneurysm, while temporal hematoma was associated with Pcom and MCA aneurysm. Frontal hematoma was associated with Acom and MCA aneurysm, Septum pellucidum was associated with Acom aneurysm, corpus collosum was associated with Acom and A2 aneurysm, and subdural hematoma was associated with MCA aneurysm.

Discussion

SAH is a common emergency condition in neurosurgery and can be a result of many factors, such as trauma, bleeding tumor, AVM, or bleeding. However, the most common cause of non-traumatic SAH is ruptured cerebral aneurysm[1,2]. Exact identification of the location of a ruptured cerebral aneurysm is important in the planning of treatment. During an open operation, the neurosurgeon can decide which cerebral aneurysm has or has not ruptured, but nowadays, endovascular treatment is frequently used and there is a great chance to identify a false ruptured cerebral aneurysm. The post-operative rebleeding has high mortality of 51%[7] and it is usually due to misinterpretation of the ruptured cerebral aneurysm in the presence of multiple aneurysm[8,9]. Direct imaging of vessels with 4-vessel digital subtraction angiography (DSA) is the gold standard for visualizing the aneurysm[10], while initial CT is the gold standard for detecting SAH and for evaluating its quantity and distribution. This information is potentially useful in focusing attention on particular parts of the circulation of the brain, and when DSA shows multiple aneurysms, it can aid identification of those that have bled. Up to 45% of patients with cerebral aneurysms have multiple aneurysms[3]. The location of cerebral aneurysm in the present report is different from that reported in other research[3-5,10] and in the current study. The highest incidence was Acom and A2 cerebral aneurysm while the second most common was internal carotid cerebral aneurysm. In contrast, other research has reported MCA as the most common location. The reason for this is unknown but could be accounted for by genetic differences between Asians and western people.

A recent publication by van der Jagt et al[11] concluded that the site of a ruptured aneurysm in the absence of a parenchymal hematoma can be identified by CT only when the bleeding originates from an A2 or an anterior Acom aneurysm. Hillman[12] and Latchaw et al[13], however, showed that the distribution of hemorrhage predicts the location of the aneurysm in over 80% of cases. Karttunen et al[14] showed that initial CT appears to be a reliable method for locating ruptured MCA and Acom aneurysms causing SAH with substantial or almost-perfect reliability. In the present study, the location of cerebral aneurysm was correlated between Acom and A2 cerebral aneurysm and position A. The authors also found a correlation between the left D position and posterior circulation aneurysm, however, only two patients had posterior circulation, therefore the results were not statistically significant.

SAH with parenchymal hematoma has been shown in other studies to be an excellent predictor of the site of a ruptured aneurysm[5,11,12]. In the present research, Rectus gyrus was associated with Acom aneurysm, while temporal hematoma was associated with Pcom and MCA aneurysm. Frontal hematoma was associated with Acom and MCA aneurysm. Septum pellucidum was associated with Acom aneurysm. Corpus collosum was associated with Acom, and A2 aneurysm, and subdural hematoma were associated with MCA aneurysm.

Conclusion

Initial CT appears to be a reliable method for locating ruptured A2 and Acom aneurysms causing SAH, and parenchymal hematoma was a predictor of the site of a ruptured aneurysm.

What is already known on this topic?

Diagnosis of which aneurysm is the cause of bleeding is very important, and cerebral angiogram is currently used in diagnosis. Another regularly-employed tool is CT pattern of SAH, but it is still a controversial modality because some studies have reported a correlation of as high as 85%, while others relate only about 10%[4,5].

What this study adds?

Initial CT appears to be a reliable method for locating ruptured A2 and Acom aneurysms causing SAH, and parenchymal hematoma was a predictor of the site of a ruptured aneurysm. The highest incidence of cerebral aneurysm in Thai patients are the Anterior communicating cerebral artery aneurysm.

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Conflicts of interest

The authors declare no conflict of interest.

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