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Comparison of Morphological Profiles between Aneurysms of Anterior and Posterior Cerebral Circulation of Sub Arachnoid Haemorrhage Patients

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Abstract:

Background: *Intracranial aneurysms (IAs) of the posterior circulation (PC) rupture more frequently and the morbidity and mortality rates are higher compared to anterior circulation. Morphological parameters such as dome neck width, size ratio (SR), believed to contribute significantly in determining the risk of rupture of intracranial aneurysms.* ***Aims:*** *To compare the morphometry of ruptured aneurysms between anterior and posterior circulation aneurysm in aneurysmal Subarachnoid haemorrhage (aSAH) patients.* ***Methods:*** *This analytical cross-sectional study was carried out in the department neurologyof National Institute of Neurosciences and Hospital, Dhaka. A total 110 patients of aneurysmal SAH confirmed by non-contrast CT scan of head having age more than 18 years, of both sexes and who gave consent were enrolled in this study. Morphologic parameter like neck width, maximum dome diameter(SR) and locations were recorded in the data collection sheet.* ***Results****: A total number of 110 patients were recruited after fulfilling inclusion and exclusion criteria. Of them two had normal findings in digital subtraction angiogram(DSA). Majority (31.5%) of the patients belonged to age group 50-59 years. Male and female ratio was 1:1.25. Regarding the morphology of aneurysm, 96 patients had aneurysm in anterior cerebral circulation and 12 patients had aneurysms in posterior cerebral circulation. Most of the aneurysms of anterior and posterior cerebral circulation were saccular in type. Fusiform aneurysms were found 3(3.1%) and 2(16.7%) in anterior and posterior cerebral circulation respectively with p value of 0.035. The mean neck width was 2.92±1.52 mm in anterior and 5.96±5.72 mm in posterior cerebral circulation($p<0.05$).* ***Conclusion****: This study revealed neck width is found to be significant differentiating factor between intracerebral aneurysms of anterior and posterior cerebral circulation. Fusiform aneurysm is significantly higher in posterior circulation. There is no significant difference in clinical profile of patients of anterior and posterior circulation.*

Keywords: *Aneurysms, Morphometry of aneurysm, Anterior and Posterior cerebral circulation, Subarachnoid hemorrhage*

Introduction:

Subarachnoid hemorrhage (SAH) is the fourth most frequent cerebrovascular disorder following embolism, atherothrombosis, and primary intracerebral haemorrhage[1]. The most common cause of SAH is trauma[2]. Most of the nontraumatic

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SAH result from ruptured aneurysms of either anterior or posterior cerebral circulation. These are designated as aneurysmal SAH or aSAH.

It results in grave consequence if it is untreated. The outcome is not favorable even in case of treated patients of SAH. Two-thirds of aSAH survivors regain functional independence but half have cognitive impairments, half are dissatisfied with life, and only one-third resume the same work as before the rupture[3]. The chance of re-bleeding is approximately 30% within 28 days of ruptured aneurysm if it is not treated[4]. Advanced age and other comorbidities contribute to the functional status and quality of life of survived patients. Poor neurological status within 24 hours after the event and large aneurysm size have been identified as predictors of mortality and poor functional outcome after SAH. The presence of intraventricular hemorrhage (IVH), intracerebral hemorrhage (ICH), and extensive radiological factors considered poor neurological outcome and mortality[5].

The annual incidence of aSAH varies across the world, ranging from 2 to 16 cases per 100,000 population, highest in Finland and Japan and a low incidence in South and Central America[6]. Though there is no such data regarding incidence, in Bangladesh. The number of subarachnoid haemorrhage patients treated in the National Institute of Neurosciences in the year 2016, and 2018 are 386 and 401 and respectively[7,8]. The risk of re-bleeding depends on the number of risk factors, morphology of the aneurysm and the site of the aneurysm. Intracranial aneurysms (IAs) of the posterior circulation (PC) rupture more frequently and their morbidity and mortality rates are higher compared to anterior circulation[9,10].

Objectives of the study

The objective of the study to find the differences of clinical features of aSAH and morphology of aneurysms between anterior and posterior cerebral circulation.

Methodology

This study was designed as analytical cross-sectional study.This study was conducted at the inpatient Departments of Neurology at National Institute of Neurosciences & Hospital, Dhaka.All aneurysmal SAH patients diagnosed clinically and radiologically with non-contrast computed tomography(CT) and digital subtraction angiogram(DSA) of cerebral vessels, of both sexes with the age group equal or more than 18years and who had given consent and who were admitted in the department of Neurology at National Institute of Neurosciences & Hospital, Dhaka- fulfilling the inclusion and exclusion criteria were selected as study population.

Study Procedure

A total 110 patients of aneurysmal SAH patient were included in the study from National Institute of Neurosciences and Hospital, Dhaka. Diagnosed case of aneurysmal SAH confirmed by radiological evidence, age more than 18 years, both sexes, presented within 48 hours, agreed to undergo DSA of Cerebral vessels and who gave consent were enrolled in this study. SAH due to Non aneurysmal bleeding, patients who denied recruitment in the study and patients who had terminal illness with multiple organ failure were excluded from the study. The patients' neurologic status was recorded within 48 hours of the event. All patients were evaluated with the WFNS scale during interview while admitted in the Department of Clinical Neurology. The digital subtraction angiograms of cerebral vessels findings were noted. The morphology and location of the aneurysm were assessed and recorded from the DSA.

Observation and Results

A total number of 110 patients were recruited after fulfilling inclusion and exclusion criteria. Two patients were found to have normal DSA. Total 108 patients' data were analyzed for the comparison of clinic-morphological features of aneurysms. Of them 96 patients had 110 aneurysms in anterior cerebral circulation and 12 patients had 12 aneurysms in the posterior circulation. There were five fusiform aneurysms including three from anterior and two from posterior circulation. Neck width and maximum dome height were measured in remaining 117 saccular aneurysms (107 saccular aneurysms in anterior circulation and 10 saccular aneurysms in posterior circulation).

Table-I

Comparison of the study patients by demographic profile between anterior and posterior cerebral circulation (n=108)

Demographic profiles	Patients with aneurysms in anterior circulation		Patients with aneurysms in posterior circulation		P value
Age group					
					0.791
20 to 29 years	3	(3.1%)	1	(8.30%)	
30 to 39 years	14	(14.6%)	3	(25.0%)	
40 to 49 years	28	(29.2%)	2	(16.7%)	
50 to 59 years	31	(32.3%)	3	(25.0%)	
60 to 69 years	14	(14.6%)	2	(16.7%)	
70 to 80 years	6	(6.3%)	1	(8.3%)	
Total	96(100%)		12(100%)		
Mean±SD	49.68±11.48		47.92±13.79		
Range (min,max)	20,78		24,70		
Sex					
Male	39	(40.6%)	9	(75.0%)	0.0245
Female	57	(59.4%)	3	(25.0%)	
Total	96(100%)	12(100%)			
Male and Female ratio 1: 1.25					

Table-II

Comparison of the study patients by type of aneurysms between anterior and posterior cerebral circulation.

Type of aneurysm	Patients with aneurysms in anterior circulation	Patients with aneurysmsin in posterior circulation	P value
Saccular	93(96.9)	10 (83.3)	0.035
Fusiform	3 (3.1)	2 (16.7)	
Others	0 (0.0)	0 (0.0)	
Total	96(100.0%)	12(100.0%)	

Almost one third (32.3%) patients belonged to age 50-59 years having aneurysms in anterior circulation and 3(25.0%) having aneurysm in posterior circulation. The mean age was 49.68±11.48 years in persons having aneurysm in anterior circulation and 47.92±13.79 years in persons having aneurysm in posterior circulation. More than half (59.4%) patients having aneurysm in anterior circulation were female and most of the persons (75.0%) having aneurysm in posterior circulation in posterior were male (Table I).

Majority patients 93(96.9%) and 10(83.3%) had saccular type of aneurysms in anterior and posterior cerebral circulation. Fusiform type of aneurysm were in 3(3.1%) and 2(16.7%) patients with aneurysms in anterior and posterior location respectively. The difference of type of aneurysm was statistically significant ($p<0.05$) between anterior and posterior (Table II).

The mean neck width was 2.79±1.3 mm in saccular aneurysm of anterior circulation and 3.83±2.31mm in posterior circulation. The mean max dome height

Table-III

Comparison of morphometric features of saccular aneurysms between anterior and posterior cerebral circulation

Morphology of aneurysm	Aneurysms in anterior circulation	Aneurysms in posterior circulation	P value
Neck width	2.79±1.3	3.83±2.31	0.027
Max Dome height	5.79±3.14	6.18±3.45	0.710
AR	2.29±1.31	1.72±0.51	0.176

Table-IV

Comparison of the study patients by the size(dome height) of aneurysms between anterior and posterior circulation

Size	Patients with aneurysms in anterior circulation		Patients with aneurysms in posterior circulation		P value
Less than 7 mm	74	(77.1%)	7	(58.3%)	
>7 to 12 mm	12	(12.5%)	3	(25.0%)	0.354
13-25 mm	10	(10.4%)	2	(16.7%)	
More than 25 mm	0	(0.0%)	0	(0.0%)	
Total	96(100.0%)		12(100.0%)		

was 5.79±3.14 mm and 6.18±3.45 mm in aneurysms of anterior and posterior circulation respectively. The mean AR was 2.29±1.31 in anterior and 1.72±0.51 in posterior. The difference of Neck width was statistically significant ($p<0.05$) between saccular aneurysms of anterior and posterior cerebral circulation (Table III).

It was observed that 74 (77.1%) patients in anterior and 7(58.3%) in posterior circulation had aneurysm size had less than 7 mm. The difference was not statistically significant ($p>0.05$) between anterior and posterior circulation (Table IV).

Discussion:

This analytical observational study was carried out with an aim to compare the Demographic profile, clinical profile of aneurysmal Sub Arachnoid haemorrhage patients and the morphological features of aneurysms of anterior and posterior cerebral circulation aneurysm.

In this present study, it was observed that most of the patients 31(32.3%) with aneurysms of anterior circulation and 3(25%) with aneurysms in posterior circulation belonged to age 50-59 years. The differences in age groups is not significant. The mean age is 49.68±11.48 years in patients with aneurysms of anterior circulation and 47.92±13.79 years in patients having aneurysms in posterior circulation. The age range varies from 20 to 78 years. Mahmud et al. observed that the mean age of their study population was 48.24±9.26 years and most of the study populations were within the age group of 38-57 year[11]. In another study Alam et al. found the mean age was 45.9 years, which was consistent with the present study[12].Tykocki et al.,Tykocki and Kostkiewicz found the mean age were 53.3±11.3 years and 53.4±12.3 years respectively, which are little bit higher than that of present study[9,10]. Similarly, in another study Rabinstein et al. found the median age was 56 years varied from 22 to 88 years[13]. The higher mean age of onset and age range obtained by the above authors maybe due to racial, ethnic differences, and genetic variation may have significant influence on the study subjects.

In the current study, it has been observed that 55.6% patients are female and 44.4% patients are male and male to female ratio is 1:1.25, which is similar to the finding of Tykocki et al. and Mahmud et al., where they found male to female ratio 1:1.76 and 1:1.6 respectively[10,11]. Similarly female predominance was observed by Tykocki and Kostkiewicz, Rabinstein et al.[10,13]. Among the patients having aneurysms in the anterior circulation 57(59.4%) are female and 39 (40.6%) are male. Most Patients 9 (75%) with aneurysms in the posterior cerebral circulation are male and rest 3(25%) were female.

Tykocki and Kostkiewiczhad hypothesis in their study that there are impact of the morphologic features of the aneurysm on the clinical course and severity of bleeding after SAH, however, it remains unexplored in large scale study till today. In the present study, it was observed that the mean neck width was 2.79±1.3mm in anterior circulation and 3.83±2.31 mm in posterior circulation. The difference is significantstatistically ($p<0.05$). Their study showed the mean neck size was 3.59±5.3 mm in anterior and 3.68±2.0 mm in posterior circulation ($P>0.05$). However, max dome height and aspect ratio (AR) were almost alike between anterior and posterior circulation in this study. The mean max dome height was 5.79±3.14 mm in anterior and 6.18±3.45 mm in posterior circulation ($P> 0.05$). The mean aspect ratio (AR) was 2.29±1.31 in anterior and 1.72±0.51in posterior circulation. The difference was not statistically significant ($p>0.05$) between anterior and posterior circulation. On the other hand, significant difference between AR was found between anterior and posterior circulation IAs for the parent (AR) which differ with the study of Tykocki and Kostkiewicz[9,10].

The most important parameter is intracranial aneurysm size. International Study of Unruptured Intracranial Aneurysms (ISUIA) is by far the largest study of its kind to examine both the natural history of unruptured aneurysms. Their data on cumulative 5year rupture rates for unruptured aneurysms at different sites suggested that the risk of rupture related to the size, site and the occurrence of a SAH from a previously treated source. For small aneurysms < 7 mm in diameter and no previous SAH, the annual risk of rupture was 0.1% (far lower than the 1–2% suggested from previous smaller studies). For aneurysms > 12 mm in diameter the annual risk of rupture ranged from 3–10% depending on the site and size. For those treated, the study also reported a combined mortality and morbidity of from 7–10% for the coiled patients and from 10–13% for the operated patients, a figure higher than surgeons had previously liked to admit. The study revealed aneurysms exceeding 10 mm in size are considered to be dangerous[14] though it may rupture in smaller size as well[15,16]. International Study of Unruptured Intracranial Aneurysms study highlights the aneurysm size in predicting of SAH. Another two studiesrevealed that the majority (about 80%) of ruptured aneurysms are less than 10 mm[17,18]. These finding are similar to the findings of this study.

Another commonly studied parameter is Aspect ratio. The aneurysm size along with blood flow and inflow angle between artery and the aneurysm and local artery caliber are commonly studied morphometric parameters. It may have an influence on intracranial aneurysm (IA) location and its rupture[19,20].

Intracranial aneurysms (IAs) located in the posterior circulation may constitute up to 30 % of all aneurysms[21,22]. Aneurysms located in the posterior circulation have a higher annual bleed rate than those in the anterior circulation. A trend of higher growth rates was found in the posterior circulation[23]. Conditions that affect the differences in the clinical course of IAs depending upon the location have not been definitively revealed. Hemodynamic properties in the aneurysmal complex might be different according to the aneurysm location. It was found that basilar artery aneurysms have the lowest average flow rate comparing to anterior location; as a result, low wall shear stress in the aneurysm dome may relate to the risk of rupture and aneurysm growth[24]. IAs in the posterior circulation were more likely to have over two times higher ARs[10]. In this study, it was observed that 44.8% patients had aneurysm at A-com artery in anterior circulation, followed by ICA

27.1%, MCA bifurcation 15.6%, P-Com artery 8.3% and DACA 4.2%. In posterior location 50.0% patients had basilar tip aneurysm, 33.4% Vertebral Artery aneurysm, 8.3% Posterior Cerebral artery and 8.3% others. The International Study of Unruptured Intracranial Aneurysms (ISUIA) reported on a retrospective and prospective multicenter study observed that aneurysm location, size, and previous SAH were risk factors for rupture. They showed that >7 mm located both posterior circulation (PC) ruptures with at rates high. This observation seems to contradict with the findings of subsequent studies. A study by Bijlenga et al. revealedthat Anterior communicating artery (A com) aneurysms rupture with smaller diameters. Furthermore, their study states that risk of rupture of aneurysms of< 7 mm size located in the internal carotid or MCA is low relative to the posterior circulation[25].

Conclusion:

Most of the patients with aneurysmal subrachnoid haemorrhage are from 5th and 6th decade of their life. Female subjects are predominant. Hypertension and smoking are the most common risk factors. Majority of the aneurysms are of < 7mm size, single, located in the anterior circulation and saccular in type. The mean neck width was significantly wider in posterior circulation compared to anterior circulation aneurysms. Maximum dome height and aspect ratio were almost similar between aneurysms of anterior and posterior circulation.

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