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ORIGINAL ARTICLE

PREVALENCE AND DISTRIBUTION OF INTRACRANIAL ANEURYSMS IN PATIENTS WITH SPONTANEOUS SUBARACHNOID HEMORRHAGE IN HAZARA DIVISION, PAKISTAN

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ABSTRACT

Background: Ruptured cerebral aneurysm is the most frequent cause of spontaneous subarachnoid hemorrhage (SAH). The objectives of this study were to determine the prevalence of intracranial aneurysms and their distribution by sex, age groups, number and location in patients with spontaneous SAH in Hazara Division, Pakistan.

Materials & Methods: This cross-sectional study was conducted at Department of Neurosurgery, Ayub Medical College, Abbottabad, Pakistan from July 01, 2017 to June 30, 2021. A sample of 119 patients with spontaneous SAH was selected. Patients with history of head trauma and bleeding disorders were excluded. Presence of intracranial aneurysms was a research variable, while sex, age groups, and number and location of aneurysms were demographic variables; all on nominal scale were analyzed by count and percentage with 95%CI.

Results: The sample of 119 patients included 50 (42%) men & 69 (58%) women, and 55 (36%) patients in 20-40 & 64 (54%) in 41-69 years. Mean age was 42.51±9.287 years. Prevalence of intracranial aneurysms in spontaneous SAH was 90 (75.63%). Prevalence was similar in men 38 (31.93%) & women 52 (43.70%, and in age group 20-40 years 42 (35.29%) & 41-60 years 48 (40.34%). The prevalence of single aneurysms 86 (72.27%) was higher than multiple aneurysms four (3.36%). Location of aneurysms was similar 43 (36.14%) in middle cerebral artery and 42 (35.29%) in anterior cerebral artery including anterior communicating artery, followed by five (4.20%) in posterior circulation.

Conclusion: In our population, prevalence of intracranial aneurysms in spontaneous SAH was 75.63%. Prevalence was similar in men and women, and in age group 20-40 and 41-60 years. Prevalence of single aneurysms was higher than multiple aneurysms. Location of aneurysms was similar in middle cerebral artery and anterior cerebral artery (including anterior communicating artery), followed by posterior circulation.

KEY WORDS: Subarachnoid Hemorrhage; Spontaneous Subarachnoid Hemorrhage; Aneurysmal Subarachnoid Hemorrhage; Intracranial Aneurysms; Cerebral Aneurysm; Middle Cerebral Artery; Anterior Cerebral Artery; Anterior Communicating Artery; Head Trauma; Prevalence.

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1. INTRODUCTION

1.1 Background: The term subarachnoid hemorrhage (SAH) denotes extravasation of blood into the subarachnoid space amid the arachnoid and pial membranes. It ensues quite some clinical scenarios; head trauma being the most frequent one.[1]

Similarly, SAH is seen with cases of nontraumatic or spontaneous hemorrhage that is normally the case with a ruptured cerebral aneurysm or arteriovenous malformation (AVM) and some other minor causes. Ruptured cerebral aneurysm is the 2nd most common cause of SAH overall and the most common cause of spontaneous SAH specifically.[2]

Aneurysms are out pouching lesions attained with hemodynamic stress, asserted through the arterial walls at bends and bifurcation points. Intracranial

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arteries with deficiency of an external elastic lamina of the wall are seen with saccular or berry aneurysms. Thin adventitia and lack of support in the subarachnoid space are supposed to be contributor to aneurysm.[3]

The incidence of SAH is different in different regions of the world but worldwide it is estimated as 9/100,000 persons/year.[4] In United States it is estimated as 30,000/year or 10/100,000 persons/year.[5,6] The epidemiology of Aneurysmal subarachnoid hemorrhage (aSAH) varies country to country, for example annual incidence rate of 2.0 per 100,000 in China vs. 22.5 per 100,000 in Finland.[7,8] According to a systematic review the incidence is less in South and Central America (4.2/100,000 persons/year) and more in Japan (22.7/100,000 persons/year) and Finland (19.7/100,000 persons/year).[4] Astonishingly, it is found that the prevalence of intracranial aneurysms is not high in Japan or Finland,[9] but the risk of rupture is higher.[10]

Recent times have shown improved management of SAH via the introduction of open surgical and endovascular techniques. In addition to this, advanced neurocritical care of patients has also made outcomes better. Even then, around 24.8% of patients die in the prime year of hemorrhage. While greater than 40% survivors have exhibited varied grades of disability. It has high mortality and high disability rates. A large volume observational study named WHO MONICA stroke study, studied 11 populations from Europe and China and concluded a 30-day case fatality rate of 42%.[8] SAH alone is held accountable for disabilities of about 18,000 people each year in the region of North America. In case of the United States, an annual cost of $1.75 billion is reported. Many people may have asymptomatic intracranial aneurysms, detectable by CTA and MRA. But as these expensive techniques cannot be applied for population screening, SAH is as such, not preventable in most such cases. Six to eight percent of the stroke cases are attributed to SAH, finding roots in the ruptured berry aneurysms.[11]

Ruptured cerebral aneurysms is risk factor for spontaneous SAH in 75%-85%.[12,13]According to a systematic review of prospective studies, the prevalence rate was estimated as 3.6-6.0% based on angiographic evaluation and autopsies.[13]According to a recent systematic review, the prevalence rate was estimated as 3.2%.[14]

Internationally, a few studies have indicated minute levels of preponderance for females.[15] An age range 40-60 has shown substantial incidence of aSAH, while comparatively younger age patients are also seen. The cause is attributed to their social and financial challenges, brought by family and society.[16,17]

Most cerebral aneurysms (80-90%) are found in anterior brain circulation (the internal carotid artery, the anterior and middle cerebral arteries, and their branches), while only 10-20% are found in the posterior circulation (the vertebral, basilar, and posterior cerebral arteries and their branches).[18]

According to a Korean study of 239 ruptured aneurysms, the locations of aneurysms noted were; the middle cerebral artery 61 cases, anterior communicating artery 66 cases, posterior communicating artery 52 cases, basilar tip aneurysms 15 cases, internal carotid artery 13 cases, anterior choroidal artery 07 cases, A1 segment of the anterior cerebral artery 03 cases, A2 segment of the anterior cerebral artery 11 cases, posterior inferior cerebellar artery 08 cases, superior cerebellar artery 02 cases, P2 segment of the posterior cerebral artery 01 case and the vertebral artery 02 cases.[19]

Butt, et al.[20] reported 50 cases of aSAH from Lahore, Pakistan from July 2015 to July 2017, including 29 (58%) women and 21 (42%) men, and 28 (56%) in 20-49 and 22 (44%) in 50-65 years age groups. They found 54 aneurysms in 50 patients; 24 (24*100/54=44.44%) at anterior communicating artery (ICA), 22 (22*100/54=40.74%) at middle cerebral artery, five (5*100/54=9.26%) at posterior communicating artery and three (3*100/54=5.56%) at ICA bifurcation.

The inclination to early bleeding has been related to location and the size of the aneurysm. Aneurysms less than 5 mm in size and predominantly those on anterior and posterior communicating vessels have greater risk of early rupture. A great shortage of data in this respect is found in the developing countries.[21] Multiple aneurysms are seen in 3-15% cases.[22,23]

Little is known about the formation and rupture of aneurysms. It is believed that epidemiological studies on SAH may guide us in comprehending the history of the disease. Moreover, it can serve to unveil the associated risks and depicting the prognostic factors that could hint the indicators of the disease mechanism.

1.2 Research Problems (RPs), Knowledge Gaps (KGs) & Rationale: No awareness regarding the prevalence and distribution of intracranial aneurysms by sex, age groups, number and location in patients with spontaneous subarachnoid hemorrhage in Hazara Division, Pakistan are our five Research Problems.

No data about these five RPs; are our five Knowledge Gaps (KGs). To unearth this unawareness is rationale of our current research work.

1.3 Research Questions (RQs)

RQ 1: What is the prevalence of intracranial aneurysms in patients with spontaneous subarachnoid hemorrhage (SAH) in Hazara Division, Pakistan?

RQ 2-3: What is the distribution of intracranial aneurysms by sex and age groups in patients with

spontaneous SAH in Hazara Division, Pakistan?

RQ 4-5: What is the distribution of intracranial aneurysms by their number and location in patients with spontaneous SAH in Hazara Division, Pakistan?

1.4 Research Objectives (ROs)

RO 1: To determine the prevalence of intracranial aneurysms in patients with spontaneous SAH

in Hazara Division, Pakistan.

RO 2-3: To determine the distribution of intracranial aneurysms by sex and age groups in patients with spontaneous SAH in Hazara Division, Pakistan.

RO 4-5: To determine the distribution of intracranial aneurysms by their number and location in patients with spontaneous SAH in Hazara Division, Pakistan.

1.5 Significance: Knowing the prevalence will help us allocating the budgets and investment to acquire equipment and human resources. Knowing the sex and age group distribution of the ruptured intracranial aneurysms will help us in diagnosis of the patients. Knowing the number and location of intracranial aneurysms will help us in selecting treatment modalities and surgical approaches to access the specific locations.

2. MATERIALS AND METHODS

2.1 Design, Settings, Duration and Ethical Considerations: This cross-sectional study was performed at the Department of Neurosurgery, Ayub Medical College, Abbottabad, Pakistan from July 01, 2017 to June 30, 2021. The data was collected from Ayub Teaching Hospital, Abbottabad; a single public teaching hospital of Hazara Division. Institutional Ethical Committee approved this study. The consent of patients/ attendants was taken for inclusion in this project.

2.2 Population, Sample Size, Technique and Sample Selection: Hazara Division is comprised of eight districts in the Khyber Pakhtunkhwa province of Pakistan with population of 5,325,121 as per 2017 Census.[24] With assumed prevalence of SAH of 1 in 1,000 persons (0.01%) in this general population, our presumed population with SAH will be 5,325 (1*5,325,121/1,000=5,325.121). This population is assumed to have intracranial aneurysms. With this much population count, with assumed prevalence of 81% intracranial aneurysms in this population from Ahmad, et al.,[25], 5.85% margin of error and 90%CL, the sample size came to be 119.[26]

The sampling technique was consecutive. All patients with spontaneous sub-arachnoid hemorrhage diagnosed by CT scan brain without contrast with age 20-60 years were eligible. Patients with history of head trauma and bleeding disorders were excluded.

2.3 Conduct of Procedure: All these patients were evaluated through detailed history, examination and investigations, including CT brain and CT-angiography. All the cases were managed by standard management protocols recommended for SAH. Air way was secured. IV line was secured. Vitals and oxygen saturation were monitored. Where appropriate, IV fluids and inotropic support were given.

2.4 Data Collection Plan: Presence of intracranial aneurysms (yes and no) was a research variable, while sex (men/ women), age groups (20-40 and 41-60 years), number and location of aneurysms were demographic/ grouping variables; all assessed on nominal scale.

2.5 Data analysis Plan: Analysis of all the five variables was done by count and percentage with 95%CL, using an online statistical calculator "Statistics Kingdom" by normal approximation method.[27]

3. RESULTS

3.1 Sample description: The sample of 119 patients with spontaneous subarachnoid hemorrhage (SAH) included 50 (42%) men & 69 (58%) women. It included 55 (36%) patients in 20-40 years age group & 64 (54%) in 41-69 years. The sample mean age was 42.51±9.287 years.

3.2 Prevalence of intracranial aneurysms in spontaneous SAH: Prevalence of intracranial aneurysms in spontaneous SAH was 90 (75.63%, 95%CI 67.92-83.34). (Table 3.2)

3.3 Distribution of intracranial aneurysms in spontaneous SAH by sex and age groups: The prevalence of intracranial aneurysms in spontaneous SAH was similar in men 38 (31.93%) & women 52 (43.70%, and in age group 20-40 years 42 (35.29%) & 41-60 years 48 (40.34%) because their confidence intervals are seen overlapping. (Table 3.3)

Table 3.2: Prevalence of intracranial aneurysms in patients with spontaneous subarachnoid hemorrhage in Hazara Division, Pakistan (n=119)

Presence of intracranial aneurysms	Count	Percentage	95% confidence interval	
			Lower	Upper
Yes	90	90*100/119=75.63	67.92	83.34
No	29	29*100/119=24.37	16.66	32.08
Total	119	100	Population parameters	

Table 3.3: Distribution of intracranial aneurysms by sex and age groups in patients with spontaneous subarachnoid hemorrhage in Hazara Division, Pakistan (n=119)

Variables	Attributes	Sample size	Count	Percentage	95% Confidence Interval	
					Lower	Upper
Sex	Men	50	38	38*100/119=31.93	23.56	40.31
	Women	69	52	52*100/119=43.70	34.79	52.61
Age groups	20-40 years	55	42	42*100/119=35.29	26.71	43.88
	41-60 years	64	48	48*100/119=40.34	31.52	49.15
Cases with intracranial aneurysms			90	90*100/119=75.63	67.92	83.34
Cases no intracranial aneurysms			29	29*100/119=24.37	16.66	32.08
Total Cases/ Sample		119	119	100%	Population Parameters	

Table 3.4: Distribution of intracranial aneurysms by its number and location in patients with spontaneous subarachnoid hemorrhage in Hazara Division, Pakistan (n=119)

Variables	Attributes	Count	Percentage	95% Confidence Interval	
				Lower	Upper
Number	Single aneurysms	86	86*100/119=72.27	64.23	80.31
	Multiple aneurysms	04	04*100/119=03.36	00.12	06.60
Location	Middle cerebral artery	43	43*100/119=36.14	27.50	44.77
	Anterior cerebral artery (including ACoA)	42	42*100/119=35.29	26.71	43.88
	Posterior circulation	05	05*100/119=04.20	00.59	07.80
Cases with intracranial aneurysms		90	90*100/119=75.63	67.92	83.34
Cases with no intracranial aneurysms		29	29*100/119=24.37	16.66	32.08
Total Cases/ Sample		119	100%	Population Parameters	

ACoA= Anterior communicating artery

3.4 Distribution of intracranial aneurysms in spontaneous SAH by their number and location: The prevalence of single aneurysms 86 (72.27%) was higher than multiple aneurysms 4 (3.36%) in patients with spontaneous SAH.

Location of aneurysms was similar 43 (36.14%) in middle cerebral artery and 42 (35.29%) in anterior cerebral artery (including anterior communicating artery), followed by five (4.20%) in posterior circulation. (Table 3.4)

4. DISCUSSION

4.1 Prevalence of intracranial aneurysms in spontaneous SAH: The prevalence of intracranial aneurysms in spontaneous SAH in our study was 75.63% (95% CI 67.92-83.34).

Higher prevalence of intracranial aneurysms in spontaneous SAH as compared to our study was reported by Ahmed, et al.[25] from Peshawar, from March to September 2020, as 81% (96*100/119) in 119 patients and by Schertz, et al.[28] from Martinique Island, France during January 2007-December 2013, as 79.3% (96*100/121) in 121 patients with spontaneous SAH.

4.2 Distribution of intracranial aneurysms in spontaneous SAH by sex: The distribution of intracranial aneurysms in spontaneous SAH was similar in men 31.93% (95%CI 23.56-40.31) and women 43.70% (95%CI 34.79-52.61) in our study, as their confidence intervals are overlapping.

Contrary to our results, higher prevalence in women 62% (620*100/1000) than men 38% (380*100/1000) was reported by Ahmad S[29] from Lahore, Pakistan, during January 2015-December 2019, with overall female/ male ratio of 1.63:1 out of 1,000 patients with aneurysmal SAH.

Similar to the above mentioned study, results by Cai, et al.[30] from Wuhan, China during May 2020-December 2020 showed higher prevalence of ruptured intracranial aneurysms as 65.01% (184*100/283) in women than 34.98% (99*100/283) in men out of 283 patients with aneurysmal SAH.

4.3 Distribution of intracranial aneurysms in spontaneous SAH by age groups: The distribution

of intracranial aneurysms in spontaneous SAH was similar in age group 20-40 years 35.29% (95%CI 26.71-43.88) and 41-60 years 40.34% (95%CI 31.52-49.15) in our study, as their confidence intervals are overlapping.

Contrary to our results, Butt, et al.[20] reported 50 patients of surgical management of aneurysmal SAH from PINS Lahore, Pakistan from July 2015-July 2017. Out of 50 patients, SAH was more prevalent 56% in age group 20-49 years than 44% in age group 50-65 years.

Kumar, et al.[31] studied the determinants of ruptured cerebral aneurysms in Chandigarh, India from June 2017-September 2017. Out of 65 patients, aneurysms were most prevalent 75.3% in age group ≥45 years, then 15.4% in age group 30-44 years and lastly 9.3% in age group 18-30 years.

4.4 Distribution of intracranial aneurysms in spontaneous SAH by number: The prevalence of single aneurysms 72.27% was higher than multiple aneurysms 03.36% in patients with spontaneous SAH in our study.

Butt, et al.[20] reported 50 patients of surgical management of aSAH from PINS Lahore, Pakistan. Out of 50 patients, the prevalence of multiple aneurysms was 04%**,** which is comparable to ours.

Contrary to our study, Juvela, et al.[32] from 1956-1978 in 142 patients and Kaminogo, et al.[33] from 1988-1998 in 2,037 patients reported that about 20% of patients with aSAH were having multiple intracranial aneurysms.

Another large study of 1,256 patients of Chinese population from January 2006-January 2013, done by Zhao L, et al.[23] reported that 14.6% of the patients had multiple aneurysms.

4.5 Distribution of intracranial aneurysms in spontaneous SAH by location: In our study, the location of aneurysms was similar 36.14% in middle cerebral artery and 35.29% in anterior cerebral artery (including anterior communicating artery), followed 4.20% in posterior circulation.

Contrary to our results, figures reported by Ahmad S[29] from Lahore, Pakistan, during January 2015-December 2019 showed that the most common location of aneurysms was anterior communicating artery 36.6%, followed by middle cerebral artery 25.4%, internal carotid artery 19.1%, posterior communicating artery 6.2%, basilar artery 6.9%, distal anterior cerebral artery 2.8% and posterior cerebral artery 1%.

Butt, et al.[20] reported 50 cases of aSAH from Lahore. They found 54 aneurysms in 50 patients; 24 (24*100/54=44.44%) at anterior communicating artery (ICA), 22 (22*100/54=40.74%) at middle cerebral artery, five (5*100/54=9.26%) at posterior communicating artery and three (3*100/54=5.56%) at ICA bifurcation.

Giordan, et al.[34] in 2019 showed the incidence of aSAH and 30-day case fatality rates during a 20-year study period (1996-2016) in Rochester, Minnesota. This study reported the location of aneurysms as internal carotid artery 12.5%, anterior cerebral artery (including anterior communicating artery) 39.4%, middle cerebral artery 15.4%, posterior communicating artery 18.3% and posterior circulation 14.4%.

4.6 Strengths of the study: We have followed seven out of eight steps of "Marwat's Logical Trajectory of Research Process"[35-37] in our study. We have not used its 8th step i.e. research hypothesis. We have defined our population, identified population at risk and then calculated the sample size. After describing our sample data, we have inferred our sample indices to population/ parameters as confidence intervals at 95% confidence level to describe our population.

5. CONCLUSIONS

In our population, prevalence of intracranial aneurysms in spontaneous SAH was 75.63%. Prevalence was similar in men and women, and in age group 20-40 and 41-60 years. Prevalence of single aneurysms was higher than multiple aneurysms. Location of aneurysms was similar in middle cerebral artery and in anterior cerebral artery (including anterior communicating artery), followed by posterior circulation.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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AUTHORS' CONTRIBUTION

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All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.