Research Article

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# Prevalence of Cerebral Aneurysms Detected by CT Angiography in Patients with Subarachnoid Hemorrhage: A Cross-Sectional Study from Karachi

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**ABSTRACT**

Subarachnoid hemorrhage is a neurological emergency often caused by ruptured cerebral aneurysms, necessitating prompt imaging for accurate diagnosis and treatment. A prospective cross-sectional study was conducted in the Liaqat National Hospital Karachi, Karachi, from July 2023 to July 2024. The study included 190 patients aged 18–60 years who were diagnosed with SAH on non-contrast CT brain. All patients subsequently underwent multidetector CT angiography to detect cerebral aneurysms. Demographic and clinical data, including age, gender, BMI, and symptom duration, were recorded. The frequency and location of detected aneurysms were analyzed. The mean age of patients was 39.5 ± 6.77 years, and the mean BMI was 29.63 ± 3.08 kg/m$^2$. Males represented 80.1% of the sample, while females comprised 19.9%. Overall, 81.3% of patients had cerebral aneurysms. Interestingly, aneurysm prevalence was higher in females (91.4%) than in males (78.7%), despite their lower proportion. A slightly higher prevalence was also observed in the 18–40 age group (84.2%) compared to the 41–60 group (80.4%). The most frequent aneurysm locations were the anterior communicating artery (28.7%), middle cerebral artery (28.3%), and posterior communicating artery (22.9%). Cerebral aneurysms were highly prevalent among SAH patients, with a notable predominance in females and in the anterior circulation. CT angiography proved to be an effective non-invasive tool for early diagnosis, underscoring its critical role in managing SAH cases promptly and accurately.

**Keywords:** Cerebral aneurysm, subarachnoid hemorrhage, CT angiography, prevalence, vascular imaging, neuroimaging, Karachi.

## INTRODUCTION

Bleeding into the subarachnoid space, predominantly due to the rupture of cerebral aneurysms, is a devastating neurological emergency known as subarachnoid hemorrhage (SAH).[1-3] Although SAH is a relatively rare vascular disorder, accounting for less than 10% of all strokes, it has substantial mortality and long-term morbidity.[4,5] SAH is typically characterized by a sudden onset of severe headache which is often referred to as 'the worst headache of life' and associated with nausea, vomiting, altered consciousness and focal neurological deficits; urgent diagnosis and intervention are needed to improve outcomes. Since aneurysmal rupture is responsible for almost 85% of spontaneous SAH, timely and accurate detection of cerebral aneurysms is crucial to direct management strategies aimed to prevent rebleeding and reduce mortality.[6,7]

Cerebral aneurysms are localized dilatations of intracranial arteries that mainly occur at arterial bifurcations in the circle of Willis because of hemodynamic stress and weakness of the intrinsic arterial wall.[8,9] Antecedent factors linked to the initiation of aneurysms and their rupture include increasing age, female sex, hypertension, smoking, genetic factors and further connective tissue conditions.[10,11] Specifically, there are more cerebral aneurysms and women are at higher risk for rupture which may be related to hormonal effects on vascular integrity.[12,13] Actual prevalence of unruptured cerebral aneurysms in the general population is estimated to be from 2–5 %, yet proportion of aneurysmal rupture among SAH patients is significantly higher.[14,15] An understanding of the aneurysm pattern in Western cohorts has been characterized by numerous epidemiological studies, however, data from South Asian countries including Pakistan remains scarce, constricting regional understanding and focused healthcare responses. Cerebrovascular diseases, including stroke, are among the leading causes of disability and death in Pakistan but advanced neurovascular imaging and specialized expertise for interventions are mostly limited to tertiary care hospitals in large cities.[16,17] This cross-sectional study was conducted in the Jinnah Postgraduate Medical





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Centre (JPMC) which is largest medical institution in Karachi as biggest metropolitan hub. The goal of this study was to evaluate the prevalence and the anatomical distribution of cerebral aneurysms using computed tomography angiography (CTA) in a population of patients presenting with SAH, by using a non-invasive modality which has very high sensitivity and specificity for intracranial aneurysm detection. Vascular imaging with rapidity, high resolution and three-dimensional resolution and a valuable option as an alternative to digital subtraction angiography (DSA) especially in emergencies where time is a crucial factor.[18,19]

We found that 81.3% of SAH patients had identifiable cerebral aneurysms on CTA, similar to the global epidemiology that ruptured aneurysm is the most common cause of non-traumatic SAH. Interestingly, women, comprising only 19.9% of the cohort, had a higher detection rate for aneurysm (91.4%,) compared with men (78.7%) which is in keeping with the established differential risk for aneurysm and rupture by gender. Comparable to prior literature, the most frequent aneurysm sites corresponded to anterior communicating artery (28.7%), middle cerebral artery (28.3%) and posterior communicating artery (22.9%) which have previously been identified as focal areas of vascular territory subject to hemodynamic stress and structural vulnerability. We performed age-stratified analysis and there was a non-significant trend for younger adults (18–40 years) to have higher aneurysm prevalence compared to older patients (40–60 years) and this may be due to a combination of genetic, environmental and undiagnosed comorbidity factors that is associated with early aneurysm formation and rupture in this population.

Burden of aneurysmal SAH in Pakistan, the diagnostic value of CTA, the need for improved neurovascular services, gender-based risk assessment and targeted management including younger patients have been highlighted in this study. For this region, it is imperative to strengthen imaging infrastructure, education and training which ultimately can improve early detection, treatment and outcomes.

## METHODOLOGY

The present study was a prospective cross-sectional investigation conducted at the Liaqat National Hospital Karachi, spanning one year from July 2023 to July 2024. The primary objective was to assess the prevalence of cerebral aneurysms among patients diagnosed with subarachnoid hemorrhage (SAH) through CT cerebral angiography. A total of 190 patients were enrolled using non-probability consecutive sampling. Patients of both genders, aged between 18 and 60 years, who presented with SAH confirmed on non-contrast CT brain and underwent CT angiography of cerebral vessels, were included. Individuals with traumatic brain injuries or prior surgical/endovascular treatment for aneurysms were excluded to avoid confounding results.

Multidetector CT angiography of the cerebral vessels was performed on all inducted patients. Intracranial vasculature were optimally imaged using contrast enhanced scans with precise timing during the arterial phase, using a standard protocol. The CT angiography was interpreted by experienced radiologists with knowledge of neuroimaging. The operational definitions included an outpouching (aneurysm) from a cerebral artery, saccular or fusiform, conforming to an operational definition of a cerebral aneurysm. Location and presence of aneurysm were recorded and these data were systematically collated for statistical analysis.

Age, sex and body mass index (BMI) as well as clinical parameters such as duration of symptoms were documented. There was 80.1% male population with the mean age of 39.5 ± 6.77 years old. We calculated mean BMI to be 29.63 ± 3.08 kg/m$^2$. Statistical software was used for analysis of the data. Continuous variables were described by mean and standard deviations and categorical variables by frequencies and percentages. Statistical significance of differences in aneurysm prevalence in the subgroups of age and gender was assessed with chi-square tests at a $p < 0.05$.

It was therefore possible by this methodological approach to identify aneurysms in a substantial number (81.3%) of those presenting with SAH. The study offered a structured method to examine the differences in the aneurysm prevalence based on age and gender and the aneurysm distribution by vessel involvement. The study utilized a defined operational definition and noninvasive imaging, in order to guarantee consistent detection criteria and reproducible results within the local clinical setting.

## RESULTS

During the study period, 190 patients with subarachnoid hemorrhage (SAH) had a CT cerebral angiogram performed. Patients were mean age of 39.5 ± 6.77 years and mean body mass index (BMI) of 29.63 ± 3.08 kg/m$^2$. Average number of days elapsed between symptom onset and imaging was 7.72 ± 2.40 days. In the study population, 80.1% were males (n=152) and 19.9% were females (n=38).

Out of the total 190 patients, 154 patients (81.3%) were found to have a cerebral aneurysm on CT angiography. The remaining 36 patients (18.7%) did not show any aneurysmal lesion. Aneurysms were more frequently detected among female patients (91.4%) compared to males (78.7%), despite the smaller proportion of female participants. This difference was not statistically significant ($p > 0.05$).

When stratified by age, the prevalence of aneurysms was slightly higher in the younger age group (18–40 years) at 84.2%, compared to the older group (41–60 years) at 80.4%. However, this difference also did not reach statistical significance ($p > 0.05$).

The anatomical distribution of aneurysms revealed the anterior communicating artery as the most frequently involved site (28.7%), followed closely by the middle

cerebral artery (28.3%), and the posterior communicating artery (22.9%). The remaining aneurysms were distributed among other vessels, including the tip of the basilar artery and less common sites.

**Table 1: Demographic and Clinical Characteristics of Patients (n = 190)**

| Variable | Mean ± SD / Frequency (%) |
|---|---|
| **Age (years)** | 39.5 ± 6.77 |
| **BMI (kg/m²)** | 29.63 ± 3.08 |
| **Duration of symptoms (days)** | 7.72 ± 2.40 |
| **Gender** | |
| **– Male** | 152 (80.1%) |
| **– Female** | 38 (19.9%) |

**Table 2: Frequency of Cerebral Aneurysms Detected on CT Angiography**

| Aneurysm Presence | Frequency (n) | Percentage (%) |
|---|---|---|
| **Present** | 154 | 81.3% |
| **Absent** | 36 | 18.7% |

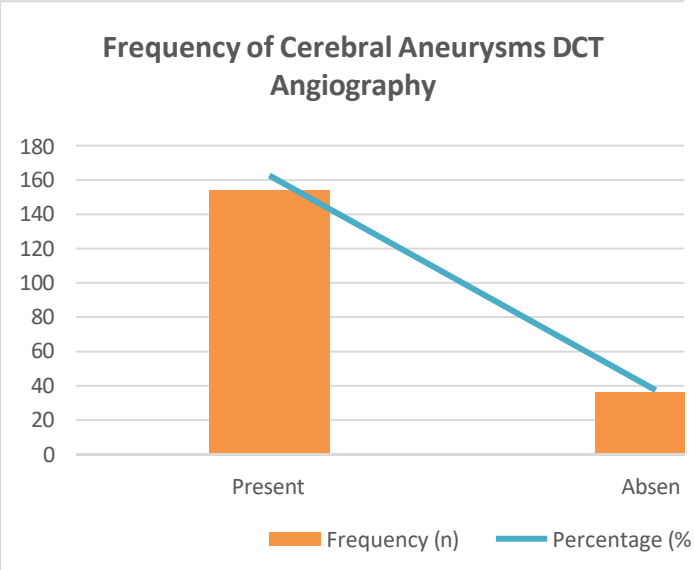



**Table 3: Gender-wise Distribution of Cerebral Aneurysms**

| Gender | Total (n) | Aneurysm Present (n) | Percentage (%) |
|---|---|---|---|
| **Male** | 152 | 120 | 78.7% |
| **Female** | 38 | 34 | 91.4% |

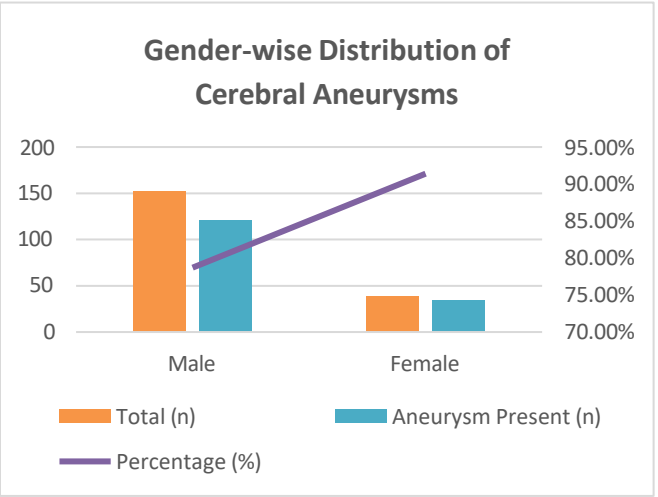



**Table 4: Age Group-wise Distribution of Cerebral Aneurysms**

| Age Group (years) | Total (n) | Aneurysm Present (n) | Percentage (%) |
|---|---|---|---|
| **18–40** | 114 | 96 | 84.2% |
| **41–60** | 76 | 61 | 80.4% |

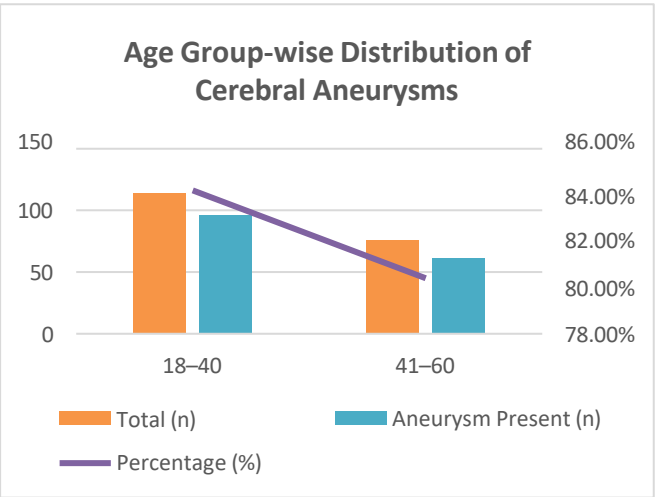
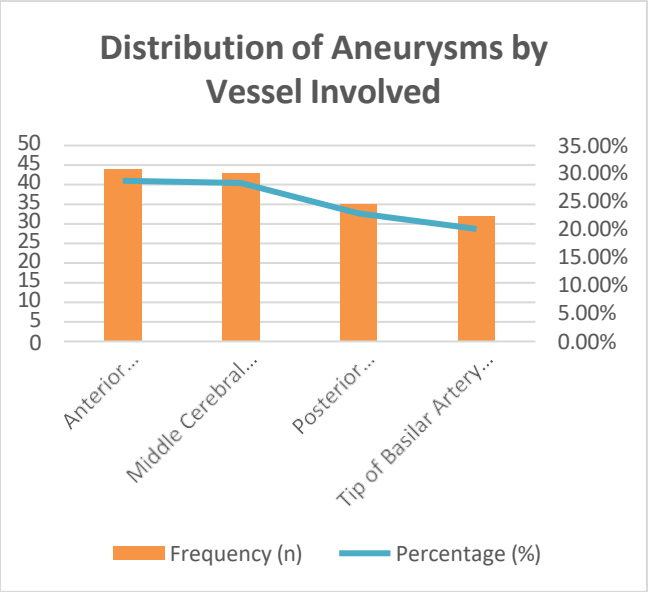



**Table 5: Distribution of Aneurysms by Vessel Involved**

| Vessel Involved | Frequency (n) | Percentage (%) |
|---|---|---|
| **Anterior Communicating Artery** | 44 | 28.7% |
| **Middle Cerebral Artery** | 43 | 28.3% |
| **Posterior Communicating Artery** | 35 | 22.9% |
| **Tip of Basilar Artery & Others** | 32 | 20.1% |




These findings demonstrate a high burden of aneurysms among patients with SAH in the study population, highlighting the importance of early CT angiography for diagnostic and treatment planning. While gender and age differences were observed in aneurysm prevalence, they were not statistically significant. The anterior communicating artery emerged as the most common site of aneurysmal involvement in this cohort.

## DISCUSSION

The purpose of the present study was to assess the prevalence and anatomical distribution of cerebral aneurysms detected by CT angiography in patients with subarachnoid hemorrhage (SAH) at a tertiary care center of Karachi. We found that cerebral aneurysms could be seen with a detectable rate of 81.3% in CT angiography of the patients with SAH. Consistent with global literature, this finding correlates to aneurysms which are the most common cause of nontraumatic SAH, with prevalence rates of 75 85% in similar studies. The results of our study confirm CT angiography as a noninvasive, accurate and readily available diagnostic modality in the acute evaluation of SAH patients where its high detection rate emphasizes its role.

Notably, the study revealed a higher aneurysmal prevalence among female patients (91.4%) compared to males (78.7%), despite females comprising only 19.9% of the study population. This gender disparity in aneurysm detection aligns with existing evidence suggesting a higher risk of aneurysm formation and rupture in females, potentially due to hormonal influences on vascular integrity and collagen synthesis. However, the difference was not statistically significant in our study, likely due to the limited number of female participants. The findings warrant further investigation through larger, gender-balanced cohorts to confirm this trend.

With regards to age, aneurysm prevalence was somewhat higher in the younger age group (18–40 years) being 84.2% and in the older group (41–60 years) being 80.4% but this difference was not statistically significant. These results were perhaps surprising given that aneurysmal SAH is generally considered more common in older populations as the result of cumulative vascular degeneration. This could perhaps be due to greater exposure in the younger group to risk factors like hypertension or smoking or it could be a referral pattern to the study center. Nevertheless, the finding of aneurysms in young patients stresses that a high index of suspicion for aneurysmal SAH should be sustained in relatively young adults.

By the vessel involvement, the aneurysms were distributed as anterior communicating artery (28.7%), middle cerebral artery (28.3%) and posterior communicating artery (22.9%) representing the most commonly affected site, respectively. This agrees with previous studies, reporting that the majority of saccular aneurysms in cases of SAH are found in the anterior circulation, specially the anterior communicating and middle cerebral artery. The anterior communicating artery is a region of known high hemodynamic stress which may cause a propensity for aneurysmal dilation and rupture there.

Our study strengthens the existing body of evidence advocating for the early use of CT angiography in all patients presenting with spontaneous SAH. Given the high prevalence of aneurysms detected and their critical role in determining the clinical course and management, prompt identification is essential for planning definitive interventions such as surgical clipping or endovascular coiling. Moreover, the data emphasize the necessity of considering demographic variables like age and gender during clinical evaluation, although their statistical association with aneurysm presence was not significant in this cohort.

## CONCLUSION

In conclusion, the study reaffirms the dominant role of aneurysms as the underlying etiology in patients with spontaneous subarachnoid hemorrhage. CT angiography emerges as an invaluable tool for timely and accurate detection of cerebral aneurysms. While trends in gender and age distribution were observed, further research with larger and more diverse populations is needed to substantiate these associations. The findings of this study have important implications for clinical practice in resource-constrained settings like Karachi, where rapid and reliable imaging can significantly impact patient outcomes in neurovascular emergencies.

### Ethical Approval

Approval No.: ERC/2023/LNH/231

### Data Availability

Available from corresponding author on request.

### Author Contributions

**Luqman Sheikh:** Contributed to the study conception and design, data collection, analysis, and manuscript drafting.
**Iftikhar Umer:** Contributed to the study conception and design, data collection, analysis, and manuscript drafting.
**Zaman Arif:** Contributed to the study conception and design, data collection, analysis, and manuscript drafting.

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**Conflict of Interest**
None.

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