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A Gender-Based Comparative Aneurysm Study Regarding Age at Presentation, Location, and Possible Causative Factors

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ABSTRACT

Objectives: The worldwide prevalence of cerebral aneurysms is estimated at 3.2%, with a female predominance of 2:1. A significant gender-specific difference also exists regarding the aneurysm location. This study aimed to find out if the South African population falls within these parameters.

Methods: This study is a cross-sectional study. The data (gender and age of patients), infarct locations and causative factors present for the 485 patients was obtained from the departments' logbooks and noted from 1 January 2015 until 31 July 2019. Only patients that showed evidence of aneurysms for the first time were included in this study to avoid duplication of the data.

Results: The mean age regardless of gender for this South African based population study was 53.1±13.0 years. Males were mainly affected in the age group 51-60 years of age. Females were more broadly affected: 51-60 years (29.8%), 41-50 years (26.8%) and 61-70 years (20.2%). The male to female ratio was 1:2.17. Two hundred and fifty (52.6%) patients had hypertension. Smoking affected 174 (35.9%) participants and hypercholesterolemia affected 90 (18.6%) patients. The most predominant aneurysm location was the anterior communicating artery.

Conclusion: The South African aneurysm statistics correlate with available international data when we assess the male to female ratio. Hypertension was the leading possible cause of aneurysms, which also correlates with the literature. A family history of aneurysms should be included in the questionnaire in the future as it is one of the biggest possible risk factors to develop aneurysms.

Keywords: Aneurysm, hypertension, intracranial aneurysm, risk factors

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INTRODUCTION

A cerebral aneurysm occurs when there is a weak, abnormal or thinned spot on an artery in the brain. It varies in size and can be small (<0.5mm), medium (6-25mm) or large (>25mm).[1,2] It balloons or "bulges out" and fills with blood, placing pressure on the surrounding nerves or brain tissue. When it finally bursts or ruptures (haemorrhages), the blood spills into the surrounding tissue and may lead to a stroke, brain damage, a coma or even death. Most aneurysms occur within the Circle of Willis (a loop of arteries that run between the inferior surface of the brain and the base of the skull). Approximately 85% of the aneurysms are located within the anterior circulation of the brain and mainly occur at junctions or bifurcations.[1]

The worldwide prevalence of cerebral aneurysms is estimated at 3.2%, with an overall gender ratio of 1:1 at the mean age of 50 years.[3] After the age of 50, a female predominance of 2:1

is seen.[1] Cerebral aneurysms and subarachnoid haemorrhage (SAH) in women peak between the ages of 50-59. Female susceptibility to cerebral aneurysms may mainly be attributed to menopause. During this period, oestrogen levels drop, compromising arterial integrity.[4]

A significant difference between gender also exists concerning the aneurysm location.[4] In a study by Ghods et al., women showed 54% of the aneurysms within the internal carotid artery (ICA) and only 15% within the anterior communicating artery (ACoA). In men, 29% of all aneurysms were found in the ACoA. They also found that women had more multiple aneurysms when compared to men. When assessing SAH, women were more affected than men. Of these ruptured aneurysms 42% were present in the ICA of women versus 47% within the ACoA of men. The majority of ruptured intra-cerebral aneurysms occurred in the posterior communicating artery (PCoA).

The specific cause of cerebral aneurysms is not clearly understood.[1–4] Aneurysms are, however, associated with several possible risk factors, including smoking, hypertension and family history.

This study aims to determine if a gender-related difference exists within the South African population when compared to international ratios regarding the different aneurysm locations noted, as well as the possible causative risk factors.

METHOD

This study is a cross-sectional study. All patient records with details of intra-cerebral aneurysms at the Intervention Radiology Departments of Drs Burger Radiology, regardless of gender or ancestry, were examined. This study was conducted for the period 1 January 2015 until 31 July 2019. Only patients that showed evidence of aneurysms for the first time were included in this study.

Data collected included the age and gender of the patients, as well as the possible causative factors, such as smoking, hypercholesterolemia and hypertension. Finally, the exact locations of the aneurysms, i.e. ACoA, PCoA, middle cerebral artery (MCA), ICA, basilar tip or the anterior choroidal artery (AChA) were noted.

Follow-up examinations were excluded to avoid duplication of data. Patients aged (0-20 years) were excluded from this study to avoid the need to obtain parental consent for inclusion in this study.

Python 3.6.5 software was used to analyse the data in this study. Descriptive variables were expressed as frequencies, percentages, mean and standard deviation. Comparisons were made using the Chi-square test. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 485 patients data were collected from the departments' logbooks. The mean age of patients was 53.1±13.0 years; the male to female ratio was 1:2.17 (153 (31.5%) males vs. 332 (68.5%) females). Data analyses showed that the most common age group affected overall, irrespective of gender, was 51-60 years (Table 1).

The most common disease accompanying aneurysm was hypertension that affected 181 (54.5%) of the female and 74 (48.4%) of the male population evaluated. Smoking affected 174 (35.9%) participants of the overall population and hypercholesterolemia 90 (18.6%). In the 128 (26.4%) participants of the overall population studied, however, both males and females did not present with the above-mentioned risk factors. Therefore, it is suggested that a family history of aneurysms can be added to the questionnaire in the future as a possible causative risk factor (Table 2).

Table 1. Aneurysms classified according to the age and gender

Age groups (Years)	Male (n=153)	Female (n=332)	Total (n=485)
11-20	1 (0.7)	2 (0.6)	3 (0.6)
21-30	4 (2.6)	11 (3.3)	15 (3.1)
31-40	26 (17.0)	27 (8.2)	53 (10.9)
41-50	37 (24.2)	89 (26.8)	126 (26.0)
51-60	51 (33.3)	99 (29.8)	150 (30.9)
61-70	25 (16.3)	67 (20.2)	92 (19.0)
71-80	6 (3.9)	28 (8.4)	34 (7.0)
81-90	3 (2.0)	9 (2.7)	12 (2.5)
Total	153 (31.5)	332 (68.5)	485 (100.0)

All data were presented as n (%).

Table 2. Possible causative risk factors according to the gender

Risk Factors	Female (n=332)	Male (n=153)	Total (n=485)
Smoke	105 (31.6)	69 (45.0)	174 (35.9)
Hypercholesterolemia	68 (20.5)	22 (14.4)	90 (18.6)
Hypertension	181 (54.5)	74 (48.4)	255 (52.6)
None of the above	89 (26.8)	39 (25.5)	128 (26.4)

All data are presented as n (%).
Since some patients had more than one aneurysm, the total was more than 100.

Aneurysms are most commonly detected within the ACoA, regardless of gender. The MCA aneurysmal incidence was similar in males and females. Female patients, however, did present with double the amount of aneurysms within the ICA. Aneurysm locations according to gender are summarized in Table 3.

In men, the ACoA was still the most predominant aneurysm location, regardless of age, closely followed by the MCA. Women, however, presented with more aneurysms in the ACoA aged 41-60 years until the age group 60-70 years. The aneurysm distribution was then slightly higher in the ICA. Women presented with a wider aneurysm location distribution throughout the ACoA, PCoA, MCA and ICA. It was also noted that as women aged, the prevalence of aneurysms within the AChA increased accordingly. Since most aneurysms were seen from ages 40-70 years, these age groups were analysed according to gender and aneurysm location in Table 4.

Table 3. Aneurysm locations according to the gender

Aneurysm location	Male (n=153)	Female (n=332)	Total (n=485)	p
ACoA	82 (53.6)	125 (37.7)	207 (42.7)	0.128
PCoA	19 (12.4)	67 (20.2)	86 (17.7)	0.350
MCA	31 (20.3)	86 (25.9)	117 (24.1)	0.114
ICA	23 (15.0)	105 (31.6)	128 (26.4)	0.153
Basilar Tip	15 (9.8)	28 (8.4)	43 (8.9)	0.046
AChA	8 (5.2)	24 (7.2)	32 (6.6)	0.020

AChA: Anterior Choroidal artery; ACoA: Anterior Communicating artery; ICA: Internal Carotid artery; MCA: Middle Cerebral artery; PCoA: Posterior Communicating artery.

All data were presented as n (%); Since some patients had more than one aneurysm, the total was more than 100.

Chi-square test.

DISCUSSION

The worldwide prevalence of cerebral aneurysms is estimated at 3.2%, with an overall gender ratio of 1:1 at the mean age of 50 years.[3] After the age of 50 years, a female predominance of 2:1 is seen.[1] The mean age, regardless of gender for this South African based population study, was 53.1 years. Males were mainly affected in the age group 51-60 years of age (33.3%). Females, however, showed a broader age group presentation. Age group 51-60 years presented with 29.8%, 41-50 years with 26.8% and 61-70 years, with 20.2% of the patients studied.

The overall affected male to female ratio was 1:2.17. The results, therefore, correspond with the literature. Cerebral aneurysms and SAH in women peak between the ages of 50-59 years. Female susceptibility to cerebral aneurysms may mainly be attributed to menopause. Oestrogen has been proven to promote normal physiological vascular endothelial function. Its effects on the vascular structures and function occur via the pleiotropic effects on the vascular endothelial cells, collagen and nitric oxide.[5]

According to literature, hypertension is the leading cause of SAH, since untreated high blood pressure damages and weakens arteries, making them more prone to rupture and tear.[1,6] Aneurismal rupture arises from increased pressure in the brain that may occur due to heavy lifting, excessive strain on the body, or by simply being upset. Untreated hypertension increases the patients' risk of aneurysms by

Table 4. Aneurysm locations according to the gender and age groups

Aneurysm location	41-50 years		51-60 years		61-70 years	
	Male (n=37)	Female (n=89)	Male (n=51)	Female (n=99)	Male (n=25)	Female (n=67)
ACoA	16 (43.2)	38 (42.7)	30 (58.8)	34 (34.3)	16 (64.0)	27 (40.3)
PCoA	2 (5.4)	17 (19.1)	7 (13.7)	16 (16.2)	6 (24.0)	20 (29.9)
MCA	11 (29.7)	22 (24.7)	8 (15.7)	27 (27.3)	7 (28.0)	23 (34.3)
ICA	4 (10.8)	27 (30.3)	7 (13.7)	29 (29.3)	4 (16.0)	29 (43.3)
Basilar Tip	5 (13.5)	7 (7.9)	7 (13.7)	9 (9.1)	1 (4.0)	7 (10.4)
AChA	1 (2.7)	3 (3.4)	2 (4.0)	7 (7.1)	1 (4.0)	11 (16.4)

AChA: Anterior Choroidal artery; ACoA: Anterior Communicating artery; ICA: Internal Carotid artery; MCA: Middle Cerebral artery; PCoA: Posterior Communicating artery.

All data were presented as n (%).

Since some patients had more than one aneurysm, the total was more than 100.

2.9 times.[6,7] Hypertension affected 52.6% of the patients (54.5% in females and 48.4% in males).

It has been reported that active smoking triples ones' risk of developing an aneurysm.[1] Smoking causes hemodynamic stress on the arterial walls, while endothelial dysfunction is induced, and inflammatory cell infiltration increases, releasing cytokine. Smoking affects every step in the cascade of events that may lead to aneurysm formation, growth and rupture.[6,8] Smokers accounted for 35.9% of the studied patient population (31.6% in females and 45.0% in males).

Atherosclerosis is defined as plaque build-up within the inner lining of an artery. These plaque deposits consist of fat, cholesterol, cellular waste products, calcium and fibrin. [1] Hypercholesterolemia was seen in 18.6% of the patients (20.5% in females and 14.4% in males). Of the overall affected patients, 26.4% did not have any of the above-mentioned risk factors.

Another risk factor associated with intracerebral aneurysms, which was not examined in this study's patient population, and that should be considered for inclusion for future studies is the family history of aneurysms. The familial occurrence of cerebral aneurysms suggests that disease susceptibility may be due to genetic factors.[8] A study conducted in 2013 suggested a 3-7 times higher risk of SAH in subjects who had a first-degree relative with a history of a ruptured intracranial aneurysm.[9] Another study conducted by Zhou et al. suggest a 9.8% higher risk of developing intracranial aneurysms for first-degree relatives older than 30 years of age when a history of one or two family members was recorded with aneurysms.[3] SAH was also noted in 10% of cases with a positive family history.

A significant difference between genders also exists regarding the aneurysm location. In a study by Ghods et al., women showed 54% of aneurysms within the ICA and only 15% within the ACoA.[4] In men, 29% of all aneurysms were found in the ACoA. They also found that women had more multiple aneurysms when compared to men. Women showed a higher likelihood of aneurysms occurring within the ICA.[4] The South African male patients' most predominant aneurysm locations were the ACoA, MCA and the ICA. Female patients presented with the most aneurysms within the ACoA, ICA, MCA and the PCoA. When comparing these frequencies of occurrence, it is seen that the results of the male patients are similar to International data, but South African women showed the reverse when noting aneurysm locations. This should be evaluated further in future studies.

One of the limitations of this study was that the data were obtained from a single practice in Gauteng. The logbooks also did not note the ancestry of the patients; thus, the predominance, according to ancestry, could not be noted. The logbooks also only noted if the patients presented with a history of hypertension, hypercholesterolemia, or if they were smokers. A family history of aneurysms was not present on the questionnaire and therefore not noted. It is recommended that this should be included in the questionnaire in the future since it is an important risk factor. This study, however, provided sufficient results as a baseline South African study.

CONCLUSION

In conclusion, South Africans aged 50-55 years presented with the highest aneurysm prevalence. Females presented with a higher prevalence than males from aged 41-70 years and might be attributed to menopause. The male to female ratio was 1: 2.17, which correlates with the literature. Hypertension affected half of the population that was studied and 26.4% of this population did not present with the most common possible causative factors, i.e. hypertension, hypercholesterolemia and smoking. The ACoA was the predominant aneurysm location noted in the sample study, regardless of gender. Unlike the literature, ACoA aneurysms were more common than ICA aneurysms in South African females.

Disclosures

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