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Size, Localization and Risk Factors in Ruptured and Unruptured Brain Aneurysms

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ABSTRACT

Brain aneurysm is a pathological focal enlargement of an artery in the brain, that is, of the inner muscle layer of the blood vessels. The vessel expands in the form of a balloon from varying degrees, where the wall of the aneurysm can become thin and rupture without warning. Brain aneurysms can form and not rupture. They are often discovered incidentally during the examination of other pathological health conditions.

***Aim:** To assess the incidence of brain aneurysms in relation to sex and age, as well as in relation to localization, size and type, that is, bleeding and non-bleeding brain aneurysms. The study also analyzes risk factors for the occurrence and outcome of brain aneurysms.*

***Material and Methods:** In the study, 80 patients with symptoms of brain aneurysm were analyzed, and diagnostic procedures were performed to prove the brain aneurysm and establish an indication for further treatment.*

***Results:** Of the analyzed patients, 48 (60%) were women, and 32 (40%) were men. In terms of age, the patients had an average age of 56.1 ± 10.3 (31-84 years). In patients with ruptured and unruptured aneurysms, there was a statistically insignificant difference in the average age between these two groups of patients 55.8 ± 9.5 vs 56.8 ± 12.3 years. Ruptured aneurysms were significantly more often diagnosed in male patients 84.38% vs 62.5% in the female population. A statistically significant difference was detected in the distribution of small, large, and giant aneurysms between the groups of ruptured and unruptured aneurysms, where it was shown that small aneurysms were insignificantly more often bleeding 77.19% vs 56.52%, large aneurysms were insignificantly more often non-bleeding 26.09% vs 21.05%, giant aneurysms were significantly more often non-bleeding 17.39% vs 1.75%. Aneurysms were non- bleeding, that is, unruptured in 28.75%, bleeding, that is, ruptured aneurysms were diagnosed in 71.25% of patients. Risk factors were present in 69 (86.25%) patients, of which the most common risk factor was hypertension, which was present in 86.25% of the patients. Hyperlipidemia was present in 33.75% of patients, while diabetes was diagnosed in 13.75%. The risk factor of smoking was present in all patients.*

***Conclusion:** Timely diagnosis of brain aneurysms is important in determining the type of aneurysm, its localization, size, and the risk of rupture. Given that non-ruptured diagnosed aneurysms carry a high risk of rupture, the establishment of an indication for endovascular treatment is of particular importance. Control of risk factors, especially smoking and hypertension, is an important segment in the prevention of the occurrence and outcome of brain aneurysms.*

Keywords
Endovascular treatment, Brain aneurysms, Ruptured/Unruptured brain aneurysms.

Introduction
Brain aneurysm represents a pathological dilation or ballooning of a blood vessel in the brain, i.e., an abnormal enlargement, in and on the wall of intracranial blood vessels. The most common are saccular (berry) aneurysms, located at the branching points of arteries, predominantly in the Circle of Willis at the base of the brain. The rupture of the blood vessel typically results in subarachnoid hemorrhage (SAH) and other intracranial bleedings [1-4].

A cerebral aneurysm may persist as unruptured, leak and cause mild subarachnoid hemorrhage, or rupture followed by massive subarachnoid hemorrhage and the formation of an intracerebral hematoma (severe hemorrhagic stroke). Ruptured brain aneurysms commonly occur in the space between the brain parenchyma and the meninges covering the brain. This type of hemorrhagic stroke is called subarachnoid hemorrhage. In fact, 90% of subarachnoid hemorrhages are due to ruptured aneurysms. In the case of a ruptured aneurysm, 33% of patients face mortality before reaching the hospital, 37% remain with significant neurological deficits, and only 30% have an acceptable neurological status. Ruptured aneurysms quickly become life-threatening and require timely, urgent medical treatment. However, most cerebral aneurysms do not rupture and are often discovered incidentally during the investigation of other pathological health conditions. They pose a health problem due to the potential risk of rupture. The treatment of patients with unruptured cerebral aneurysms is elective depending on the symptoms, localization, and size, aiming to prevent future rupture. The best time for aneurysm treatment is before rupture, highlighting that timely, early diagnosis and treatment reduce morbidity and mortality from cerebral aneurysms [3,5-9].

Aneurysms generally form at artery bifurcation points, as these areas are weakest. Occasionally, cerebral aneurysms may be present at birth, typically due to abnormalities in the artery wall. The exact mechanisms through which cerebral aneurysms develop, grow, and rupture are still not fully known, but several factors, including modifying and non-modifying risk factors, wall stress, endothelial dysfunction, and inflammation, are implicated. Sometimes, cerebral aneurysms result from hereditary risk factors, including genetic disorders of connective tissue that weaken artery walls, arteriovenous malformations, as seen in polycystic kidney disease. A family history of aneurysms in first-degree relatives (child, sibling, or parent) suggests a higher risk of aneurysm rupture in family members. The highest risk occurs in individuals with multiple aneurysms who have previously experienced a rupture or bleeding [2,3,10]. Risk factors described in the literature that can cause and complicate aneurysms include smoking, untreated hypertension, hypercholesterolemia, diabetes, and other known modifying risk factors. Substance abuse, particularly cocaine or amphetamine, increases the risk of aneurysm development. Unusual risk factors include cranial trauma, brain tumors, and infection in the arterial wall (mycotic aneurysm) [2,3,7,10]. Aneurysms are classified by size into: small aneurysms (less than 11 millimeters in diameter), large aneurysms (11 to 25 millimeters), and giant aneurysms (more than 25 millimeters).

Aneurysms also vary in shape:
- Saccular aneurysmal enlargements, which have a neck, sac, and apex or dome;
- Fusiform aneurysmal enlargements, which can be dissecting (post-traumatic being the most common form);
- Blister aneurysms, which are lateral enlargements without a neck.

Giant saccular aneurysms present a particularly high risk of rupture [3,4,8-11].

The Aim of this study was to assess the age and sex of patients with cerebral aneurysms, identify present risk factors in patients, determine the size and localization of cerebral aneurysms, and analyze the characteristics of aneurysm types in patients referred for diagnosis and treatment due to cerebral aneurysms.

Materials and Methods
In this study, 80 patients with symptoms of cerebral aneurysm, indicated for diagnosis and potential treatment by neurosurgery, were analyzed. The study also included and selected patients with incidentally discovered aneurysms during head computed tomography (CT) scans. Patients included in the study were followed for the next 6 months regarding the occurrence of complications and mortality. The study is a retrospective-prospective clinical observational study.

Demographic data (age, sex), present risk factors, and past diseases of the patients were analyzed, with particular attention to risk factors such as the presence of aneurysms in the family, smoking, hypertension, diabetes, high LDL cholesterol and triglycerides, and diabetes. The conducted examinations provided data on the location, size, and condition of the aneurysm, i.e., whether it was a ruptured or unruptured aneurysm. Inclusion criteria for analysis were patients with cerebral aneurysm (small, large, giant), ruptured or unruptured, and age over 18 years.

For the diagnosis of cerebral aneurysms, several methods were used:
- Computed Tomography (CT) of the Brain: This was usually the first method used to determine if there was intracranial hemorrhage.
- CT Angiography (CTA) of the Brain: After contrast application, this method facilitated the diagnosis of blood vessels in the brain and could indicate the presence of an aneurysm with detailed analysis and appropriate parameters for further treatment.
- Magnetic Resonance Imaging (MRI): Using magnetic fields and radio waves, this provided detailed images of the brain,

either 2D sections or 3D images with special software solutions. With MR Angiography (MRA), arteries could be detailed assessed, and the presence of an aneurysm could be detected.

- Digital Subtraction Angiography (DSA) or Seldinger Puncture Angiography, also called a cerebral angiogram: A thin, flexible tube (catheter) is placed in a large artery usually the femoral artery which travels through the aortic arch, past the heart, to the arteries in the brain. Iodine contrast material is injected into the catheter, which travels to the brain's arteries. A series of X-ray images can reveal details about the condition of the arteries and diagnose the aneurysm and hemodynamics in real-time. This method is minimally invasive and is usually used when other diagnostic tests do not provide sufficient information. DSA or Seldinger Puncture Angiography is a key method (gold standard) in the therapeutic approach for completely resolving the aneurysm using coiling, regardless of whether it is a bleeding or non-bleeding aneurysm.

Statistical Analysis

The statistical analysis of the data obtained from the research was conducted using the statistical program SPSS 23.0. Kolmogorov-Smirnov and Shapiro-Wilk tests were used to test the normality of the data distribution. The obtained data are presented in tables and graphs. Categorical (attribute) variables are presented with absolute and relative numbers. Numerical (quantitative) variables are presented with mean, standard deviation, minimum and maximum values, median value, and interquartile range. For comparing the groups with ruptured and unruptured aneurysms, non-parametric and parametric tests for independent samples (Chi-square test, Fisher exact test, Student t-test) were used. Statistical significance was defined at a level of $p<0.05$.

Results

In this study, 80 patients with confirmed brain aneurysms, examined due to symptoms of aneurysm, were analyzed. Of the analyzed patients, 48 (60%) were women, and 32 (40%) were men. Regarding age, the patients had an average age of 56.1 ± 10.3 (from 31 to 84 years). The distribution by sex and age is shown in Table 1.

Table 1: Statistical Analysis of Patients with Cerebral Aneurysms by Sex, Age, Location, Size, and Risk Factors.

Variable	n (%)
Sex Female Male	48 (60) 32 (40)
Age (years) (mean ± SD) (min – max)	56.1 ± 10.3 (31 – 84)

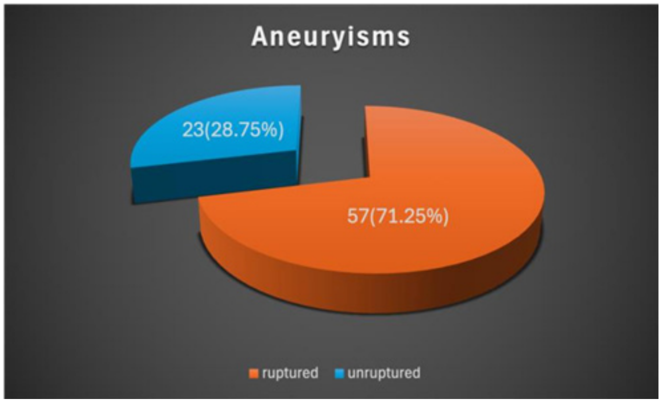
Patients with confirmed aneurysms were analyzed by the location and size of the aneurysm (Table 2), as well as the outcome of the present aneurysm, i.e., whether a ruptured or unruptured aneurysm was diagnosed (Graph 1). The present risk factors in diagnosed and treated patients were also analyzed.

In 78 (97.5%) of the patients, the aneurysms were located anteriorly, and only in 2 (2.5%) patients were they located posteriorly. The majority of patients had small aneurysms, i.e., 57 (71.25%) patients, 18 (22.5%) patients had large aneurysms, and only 5 (6.25%) patients had giant aneurysms (Table 2).

Table 2: Statistical analysis of patients with brain aneurysms by location and size of aneurysm.

Variable	n (%)
Location of Aneurysm Anterior Posterior	 78 (97.5) 2 (2.5)
Size of Aneurysm Small Large Giant	57 (71.25) 18 (22.5) 5 (6.25)

The aneurysms were non-bleeding, i.e., unruptured in 23 (28.75%) patients, while bleeding, i.e., ruptured aneurysms were diagnosed in 57 (71.25%) patients (Graph 1). Regarding the type of bleeding, 32 (40%) patients had only subarachnoid hemorrhage, 9 (11.25%) patients had intracerebral hemorrhage, 14 (17.5%) patients had intraventricular hemorrhage, and 2 (2.5%) patients had subarachnoid hemorrhage with intracerebral and intraventricular hemorrhage.



Graph 1: Distribution of ruptured and unruptured aneurysms.

The patients with ruptured and unruptured aneurysms had similar ages, with a statistically insignificant difference in the average age between these two groups of patients (55.8 ± 9.5 vs 56.8 ± 12.3 years), as shown in Table 3.

Table 3: Statistical analysis of patients with ruptured and unruptured brain aneurysms by Sex and Age.

Variable		Ruptured Aneurysms			p - value
		n	**Yes** n (%)	**No** n (%)	
Sex	Female	48	30 (62.50)	18 (37.50)	X^2=4.5 *p=0.034 (p<0.05)
	Male	32	27 (84.38)	5 (15.63)	
Age (years)	n	57		23	t=0.4 p=0.69
	mean ± SD	55.8± 9.5		56.8 ± 12.3	
	min – max	31 – 84		31 75	

X^2(Pearson Chi-square); t(Student t-test), *p<0.05.

Both aneurysms located posteriorly were bleeding (Table 4). A statistically significant difference was detected in the distribution of small, large, and giant aneurysms between the groups of ruptured and unruptured aneurysms (p=0.026). Tested differences in the percentage presence of small, large, and giant aneurysms in the groups of ruptured and unruptured showed that small aneurysms were insignificantly more often bleeding – 44 (77.19%) vs 13 (56.52%), p=0.06. Large aneurysms were insignificantly more often non-bleeding – 6 (26.09%) vs 12 (21.05%), p=0.62. Giant aneurysms were significantly more often non-bleeding – 4 (17.39%) vs 1 (1.75%), p=0.0089 (Table 4).

Table 4: Statistical analysis of patients with ruptured and unruptured brain aneurysms by Location and Size.

Variable		Ruptured Aneurysms			p - value	
		n	Yes n (%)	No n (%)		
Location of Aneurysm	Anterior	78	55 (96.49)	23 (100)	X^2=0.8 p=0.36	
	Posterior	2	2 (3.51)	0		
Size of Aneurysm	Small	57	44 (77.19)	13 (56.52)	Fisher's exact test *p=0.026	[1]p=0.06
	Large	18	12 (21.05)	6 (26.09)		[1]p=0.62
	Giant	5	1 (1.75)	4 (17.39)		[1]*p=0.0089

[1]p(difference two proportions); *p<0.05, **p<0.01.

All patients with brain aneurysms in our analyzed group were smokers, hence the risk factor of smoking was not analyzed in relation to aneurysm type, location, and outcome. Regarding other risk factors, among the analyzed patients with cerebral aneurysms, risk factors were present in 69 (86.25%) patients, with the most common risk factor being hypertension, present in 86.25% of the patients. Hyperlipidemia was present in 33.75% of the patients, while diabetes was diagnosed in 13.75% of the patients (Table 5).

Table 5: Percentage presence of risk factors in patients with brain aneurysms.

Variable	n (%)
Risk Factor	69(86.25%)
Diabetes	11 (13.75%)
Hyperlipidemia	27 (33.75%)
Hypertension	69 (86.25%)

Risk factors for the occurrence of aneurysms were present in 47 (82.46%) patients from the group with ruptured aneurysms and 22 (95.65%) patients with unruptured aneurysms. There was no statistically significant difference (p=0.12) between the type of aneurysm (ruptured/unruptured) and the presence of risk factors. Diabetes was more common in patients with ruptured aneurysms – 11 (19.3%) vs 0, p=0.023. Regarding the risk factor of hyperlipidemia, it was more prevalent in the group with unruptured aneurysms, present in 17 (29.82%) patients with ruptured aneurysms and 10 (43.48%) patients with unruptured aneurysms. There was no statistically significant difference regarding the risk factor of high blood pressure between the types of aneurysms in the studied group, with 47 (82.46%) patients having ruptured and 22 (95.65%) patients having unruptured aneurysms. No statistically significant difference was found in the distribution of patients with/without hyperlipidemia and with/without hypertension between the groups of ruptured and unruptured aneurysms (p=0.24, p=0.12, respectively) (Table 6).

Table 6: Statistical analysis of patients with ruptured and unruptured brain aneurysms by Risk Factors.

Variable		Ruptured Aneurysms			p - value
		n	Yes n (%)	No n (%)	
Risk Factor	Yes	69	47 (82.46)	22 (95.65)	X^2=2.41 p=0.12
	No	11	10 (17.54)	1 (4.35)	
Diabetes	Yes	11	11 (19.3)	0	X^2=5.15 *p=0.023
	No	69	46 (80.7)	23 (100)	
Hyperlipidemia	Yes	27	17 (29.82)	10 (43.48)	X^2=1.4 p=0.24
	No	53	40 (70.18)	13 (56.52)	
Hypertension	Yes	69	47 (82.46)	22 (95.65)	X^2=2.4 p=0.12
	No	11	10 (17.54)	1 (4.35)	

X^2 (Pearson Chi-square) *p<0.05.

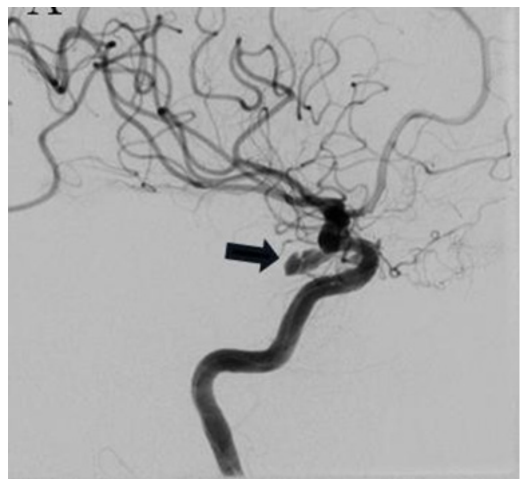


Figure 1: Large bleeding saccular aneurysm on the left ICA-PCOM (Material from investigated patients).

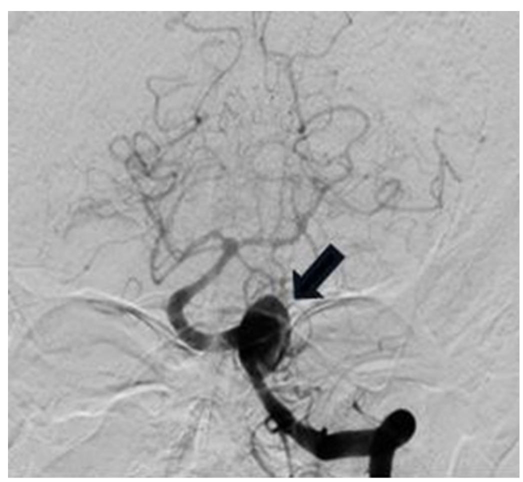


Figure 2: Large bleeding saccular aneurysm on the left vertebral artery-PICA (Material from investigated patients).

Discussion

Brain aneurysms (BA), which are focal enlargements of the arterial wall, can cause sudden rupture of the thinned wall, leading to subarachnoid hemorrhage. This accounts for over 25% of stroke cases and has a high mortality rate or can be fatal. The incidence of cerebral aneurysms ranges from 1-6%, with a prevalence of 3.2% in the adult population. Early detection of aneurysms and therapeutic strategies are crucial in reducing the incidence of rupture and mortality from BA [12]. With the aging population and advancements in neuroimaging diagnostics, an increasing number of older patients are being diagnosed with cerebral aneurysms. In our study, the median age of the analyzed patients was 56 ± 10.3 years, with a wide age range from 31 to 84 years. Interestingly, patients with ruptured and unruptured aneurysms had similar ages, with no statistically significant difference in the average age between these two groups of patients (55.8 ± 9.5 vs 56.8 ± 12.3 years). A Japanese cohort study on the natural course of cerebral aneurysms reported that 28% of patients with unruptured BA were older than 70 years [3]. Another study reported that aneurysms grow over time, with those in patients aged 60 or older being larger than in those younger than 60. However, no connection between size, age, and outcome was observed. In the same study, an increase in aneurysm size with age was noted for unruptured aneurysms and significantly for ruptured aneurysms of the central cerebral artery compared to other aneurysm locations [13].

In the majority of published studies, cerebral aneurysms are more common in women compared to men, which was also the case in our study. Of the analyzed patients, 48 (60%) were women and 32 (40%) were men. Indeed, according to multiple studies, there is a difference in the occurrence of cerebral aneurysms by gender. The cause of cerebral aneurysms is considered to be multifactorial. Besides geographic location, the organization of the health system regarding the implementation of primary and secondary prevention, dietary habits, and potential risk from ethnic or racial differences can play a role in the incidence and prevalence [14]. Studies have been published indicating that cerebral aneurysms are more common in adolescent males, while the dominance shifts to females in older age [15,16]. The female gender is considered an independent risk factor for the growth and rupture of aneurysms, and the lack of estrogen, especially in postmenopausal women, has a significant impact on the pathophysiology of aneurysm formation and rupture [17,18]. Estrogen has been shown to influence vascular endothelial function and improve the normal physiological vascular system. Ruptured aneurysms were more predominant in young adult men with relatively low estrogen levels compared to women [17,19].

The gender structure of patients with ruptured and unruptured aneurysms was significantly different ($p<0.05$) in our study. Ruptured aneurysms were significantly more often diagnosed in male patients, which differs from some published studies and meta-analyses. In several meta-analyses, women had a higher risk of rupture of cerebral aneurysms compared to men, but female gender was not an independent risk factor [20]. In the study utilizing the PHASES score, the data on smoking and a positive family history of subarachnoid hemorrhage were used to assess the 5-year risk of rupture of unruptured intracranial aneurysms (UIA). Several risk factors related to the patient and the aneurysm itself were considered, including geographic location, hypertension, age, history of intracranial hemorrhage, and the size and location of the aneurysm [21]. The PHASES score results are based on a comprehensive analysis of patient data from prospective cohort studies on the rupture rate of intracranial aneurysms and risk factors for rupture. In this pooled analysis, women had a higher risk of rupture, but in the multivariable analysis, female gender was not an independent risk factor. Another meta-analysis, including both retrospective and prospective studies, reported a statistically significantly higher risk of rupture in women compared to men, but female gender could not be proven as an independent risk factor because multivariable analysis was not possible due to a lack of individual patient data [22]. Likely, other factors are important in the occurrence of rupture in the female population, such as specific female hormones and reproductive factors, which is a limitation in our study due to the lack of division of patients into age groups, especially the division of premenopausal and postmenopausal women. There is data indicating that the rupture of cerebral aneurysms is more common in postmenopausal women compared to premenopausal women.

There are also considerations that the X chromosome, sex-specific effects of present risk factors, which may have a significant effect in women, could explain the differences between genders, but there is still no concrete evidence [21]. One of the limitations of the published results is the lack of follow-up regarding aneurysm growth, the aggressiveness of treatment, persistence of risk factors, and the duration of follow-up after treatment. Published studies only report the presence of risk factors at the time of cerebral aneurysm detection but not during the follow-up period. Nevertheless, all this suggests a more aggressive treatment approach in the female population and the need for further studies focused on identifying the risks for more frequent ruptures, including different follow-up approaches, specific hormonal and reproductive factors, and certainly modifiable risk factors [12,21].

In our study, all patients with cerebral aneurysms were smokers, so the risk factor of smoking (100%) was not included in the analysis regarding aneurysm outcomes. Regarding the remaining risk factors, cerebral aneurysms were present in 69 (86.25%) of the analyzed patients, with hypertension being the most common risk factor, present in 86.25% of the patients, dyslipidemia in 33.75%, and diabetes diagnosed in 13.75%. All these risk factors are considered modifiable and important because their presence can contribute to the damage of the blood vessel wall. Smoking and hypertension can cause endothelial dysfunction of the blood vessel and an inflammatory response, leading to vessel damage and the formation of cerebral aneurysms. The presence of multiple risk factors can cause hemodynamic changes in the vessel wall, initiating the formation of an aneurysm, and playing a crucial role in maintaining the risk of rupture. The wall in a certain segment can lose its elasticity and muscular components, leading to the formation of an aneurysm. In recent years, more attention has been given to the role of hemodynamic forces, or wall stress, in the initiation of aneurysms, their growth, and rupture [12]. In our study, there was no statistically significant difference between the type of aneurysm (ruptured/unruptured) and the presence of risk factors. Diabetes and hypertension were more common in patients with ruptured aneurysms, while the risk factor of hyperlipidemia was more prevalent in the unruptured aneurysm group. In recent years, unruptured intracranial aneurysms are being detected with increased frequency incidentally due to the widespread use of high-resolution magnetic resonance imaging (MRI). A large percentage of cerebral aneurysms will never rupture. For example, out of 1 million adults in the general population with an average age of 50 years, only 0.25% of them, or 1 in 200 to 400, will experience a rupture [7]. However, we have seen that multiple factors are important in the outcome of aneurysms.

In the literature, studies regarding the localization of aneurysms indicate that the highest risk of rupture is associated with aneurysms located in the anterior circulation, predominantly in the anterior cerebral artery (ACA), followed by aneurysms located in the internal carotid artery (ICA). The middle cerebral artery (MCA) follows next. The posterior circulation is represented with the smallest percentage. Aneurysms of the anterior cerebral artery include those originating from the proximal anterior cerebral artery and the anterior communicating artery. Aneurysms of the internal carotid artery include those originating from its bifurcation, the anterior choroidal artery, the posterior communicating artery, and the paraclinoid internal carotid artery. The incidence of aneurysm rupture in patients younger than 40 years is 10-20% [19]. Young adult patients with ruptured aneurysms generally showed a good prognosis, with rare cases of perioperative mortality. Clinical outcomes are generally favorable due to the low incidence of hydrocephalus, severe vasospasm, and other medical issues [23-25].

Regarding morphological parameters, cerebral aneurysms are characterized by their size and shape, in addition to their location. In our study, patients with confirmed aneurysms were analyzed based on the location and size of the aneurysm, as well as the outcome of the present aneurysm, specifically whether the aneurysm was diagnosed as ruptured or unruptured. In 78 (97.5%) of the patients, the aneurysms had an anterior location, and only 2 (2.5%) patients had a posterior location, which aligns with published results [3]. The two patients with posterior localization had bleeding complications. A statistically significant difference was detected in the distribution of small, large, and giant aneurysms between the groups of ruptured and unruptured aneurysms in the studied group. Among the analyzed patients, the majority had small aneurysms, specifically 57 (71.25%) patients, large aneurysms in 18 (22.5%) patients, and only 5 (6.25%) patients had giant aneurysms. Small aneurysms were slightly more likely to be bleeding, large aneurysms were slightly more likely to be non-bleeding, while giant aneurysms were significantly more likely to be non-bleeding. Aneurysms were non-bleeding, i.e., unruptured in 23 (28.75%) patients, while bleeding, i.e., ruptured aneurysms, were diagnosed in 57 (71.25%) patients.

Regarding the type of bleeding, 32 (40%) patients had only subarachnoid hemorrhage, 9 (11.25%) patients had intracerebral hemorrhage, 14 (17.5%) patients had intraventricular hemorrhage, and 2 (2.5%) patients had subarachnoid hemorrhage with intracerebral and intraventricular hemorrhage. Larger aneurysms are considered to be at higher risk of rupture, but the relationship between aneurysm size and rupture is still controversial. Some studies suggest that aneurysms of 7-10 mm have an increased risk of rupture, while others disagree and consider that even smaller aneurysms are at risk of rupture, indicating that size is not the only risk factor important for assessing the likelihood of rupture. The growth rate is also an important parameter in assessing the risk of rupture. Another important aspect is the shape. Aneurysms with an irregular shape, such as fusiform aneurysms, have a higher risk of rupture compared to spherical aneurysms. Fusiform aneurysms suggest increased wall stress, leading to endothelial dysfunction, inflammation, and vessel wall damage. Intraluminal thrombosis is also considered a risk factor for increased rupture incidence due to increased wall stress on the blood vessel. Hemodynamic characteristics of blood flow are additional risk factors [12]. The multifactorial nature of cerebral aneurysms can make it difficult to predict the risk of rupture. In addition to traditional risk assessment, the dynamic nature of blood flow and its interaction with the vessel wall must also be considered. This explains why some very small aneurysms rupture while some large aneurysms remain unruptured. Advanced imaging techniques can aid in assessing the likelihood of rupture [12]. However, additional research is needed to improve the accuracy of risk assessment and the prediction of cerebral aneurysm rupture.

Conclusion

Different studies report varying prevalence of cerebral aneurysms by gender, but further research is needed to identify the factors determining the risk of formation, growth, and rupture of cerebral aneurysms. The outcome of cerebral aneurysms depends on various factors including the time of diagnosis, size, location, presence of risk factors, possible complications, and the effectiveness of treatment. Controlling risk factors, especially smoking and hypertension, is an important aspect in the prevention and outcome of cerebral aneurysms. Timely diagnosis of cerebral aneurysms is crucial in determining the type of aneurysm, its location, size, and risk of rupture. Given that unruptured diagnosed aneurysms carry a high risk of rupture, indicating endovascular treatment is of particular importance.

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