

Clinical Complications of Hemorrhagic Stroke from Intracranial Aneurysm: An Integrative Review



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Abstract

Background: Stroke is a significant alteration in blood flow, often caused by an obstruction or rupture of the arterial vessel wall. Hemorrhagic stroke can result from the rupture of an intracranial aneurysm, characterized by an abnormal dilation of an artery. Understanding the clinical outcomes and complications associated with hemorrhagic strokes resulting from intracranial aneurysms is crucial for improving patient care and outcomes. **Methods:** This study conducted an integrative literature review using the PRISMA and PICO models. The research question guiding the review was: "What are the clinical complications of stroke resulting from cerebral aneurysm?" Databases searched included PubMed and BVS (LILACS and MEDLINE), using Health Sciences Descriptors (DeCS): (Stroke) AND (Aneurysm) AND (Intracranial hemorrhage) AND (Artery). The Boolean Operator "AND" was used to refine the search. Of the initial 321 articles identified, 27 were selected for full-text review based on title and abstract screening. Ultimately, 15 articles met the inclusion criteria and were included in the final analysis. **Results:** The review found that aneurysm rupture is a major cause of new stroke cases, accounting

for approximately 85% of subarachnoid hemorrhage instances. The majority of these cases occur in males, which may be attributed to lifestyle-related factors such as smoking and dyslipidemia. Clinical manifestations of aneurysmal stroke vary but commonly include severe headaches rated 10/10 on the pain scale. Advanced age is also identified as a significant risk factor. **Conclusion:** The study concludes that the incidence of hemorrhagic stroke due to aneurysm rupture is higher in males, with major risk factors including advanced age, smoking, and dyslipidemia. Complications from cerebral aneurysms are significantly correlated with the clinical outcomes of hemorrhagic strokes. Understanding these correlations aids in diagnosing and managing probable complications, thereby improving clinical outcomes for patients with hemorrhagic stroke due to intracranial aneurysms.

Keywords: Hemorrhagic stroke, Intracranial aneurysm, Subarachnoid hemorrhage, Clinical outcomes, Risk factors

Significance | Understanding hemorrhagic stroke complications from intracranial aneurysms informs better diagnosis, treatment, and prevention strategies to improve patient outcomes.

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Introduction

The United Nations (UN) states that stroke causes an average of 6 million deaths per year worldwide. Stroke can occur through blood vessel obstruction, known as ischemic stroke, or from a rupture of the vascular artery, known as hemorrhagic stroke (Beltrán Rodríguez I, et al., 2020).

In correlation with this, there is cerebral aneurysm, which is defined as an increase in the normal diameter of the artery, which can occur in the brain (where they are most common), as well as in the arteries

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of the heart, abdomen, or kidney. High mortality rates are associated with intracranial aneurysms, thoracic and abdominal aortic aneurysms, which can result from atherosclerotic disease or hypertensive peaks (Brasil, 2018).

Furthermore, cerebral aneurysms form from dilations of blood vessels (>50% of the initial diameter) in cerebral circulation. Consequently, aneurysms increase the risk of rupture, which can lead to a hemorrhagic stroke episode, such as Subarachnoid Hemorrhage, representing the most frequent rupture of intracranial aneurysms, linked to symptoms such as intense headache, neck stiffness, vomiting, seizures, neurological deficits, and even fainting episodes (Kunzendorff BA, et al., 2018).

In the case of subarachnoid hemorrhage, one type of intracerebral hemorrhage, the blood clot is located between the brain and the arachnoid (one of the meninges membranes), resulting in elevated intracranial pressure, thus impeding blood flow to other parts of the body, causing injury aggravation (Colton K, et al., 2020).

Non-traumatic intracerebral hemorrhage causes include aging, genetic factors, smoking, high cholesterol levels, excessive alcohol and drug use. Moreover, other pathologies are related, such as vascular anomalies, brain tumors, intracranial arterial aneurysm, cranial trauma, cerebral arteriovenous malformation, intracranial venous thrombosis, among others (Bai et al., 2020).

In this regard, Intracranial Aneurysms (IA) are dilations of brain arteries resulting from vascular wall fragility due to the lack of type III collagen in the tunica media and internal elastic lamina, causing pathophysiological dysfunctions (Wang et al., 2018). Therefore, it is important to highlight that IA's etiopathogenesis occurs due to various factors, including smoking, systemic arterial hypertension, cerebral arteriovenous malformation, among others (Wipplinger C, et al., 2020).

It is also relevant to highlight diseases that increase stroke risk, such as arterial hypertension, obesity, dyslipidemia, smoking, sedentarism, and heart diseases like arrhythmias and valvulopathies. Atherosclerosis, a disease causing changes in blood vessel walls leading to progressive obstruction, is also considered a common stroke cause (Bugge HF, et al., 2022).

Thus, the rehabilitation of patients affected by a hemorrhagic stroke requires patience and perseverance from the patient and their caregiver, who plays an essential role in this process. Another important consideration is the reintegration of the individual into social life (Shkirkova K, et al., 2020).

Therefore, it is crucial to diagnose and treat intracranial aneurysm with knowledge and agility to prevent associated complications such as hemorrhagic stroke. Moreover, precisely identifying aneurysm anatomy and the most appropriate treatment for each case, minimizing brain injuries, and treating complications is the primary goal in stroke treatment (Lobo, P., et al., 2021).

This study aimed to synthesize an integrative literature review on hemorrhagic stroke resulting from intracranial aneurysm to correlate the two events by addressing symptomatological aspects and their clinical outcomes.

Methodology

This study is an integrative review following a systematic model, conducted through searches in electronic journals within the PubMed and BVS (LILACS AND MEDLINE) databases. The guiding question was: "**What are the clinical complications of stroke resulting from cerebral aneurysm?**" The following Health Sciences Descriptors (DeCS) were used: (Stroke) AND (Aneurysm) AND (Intracranial hemorrhage) AND (Artery), utilizing the Boolean Operator "AND." Inclusion criteria were determined as retrospective observational and experimental studies that are complete and freely accessible, published in the last five years (2018-2023), in English, Portuguese, and Spanish, presenting the clinical and pathophysiological outcomes of hemorrhagic stroke and cerebral aneurysm, and possibly including epidemiological and morbidity and mortality data. Articles that did not meet the eligibility criteria or presented the following aspects were excluded: duplicate articles or those with insignificant samples.

Following the review model, six phases of sample analysis were established. **Phase 1** (Elaboration of the guiding question): The objective is to direct the applied research. **Phase 2** (Search for samples in the literature): The DeCS were applied in the databases, finding PubMed N=33, BVS (Lilacs) N=100, and BVS (Medline) N=188, totaling an initial universe of 321 articles. **Phase 3** (Data collection): Based on the analysis of titles and abstracts, PubMed N=10, BVS (Lilacs) N=20, and BVS (Medline) N=12 were selected, totaling 42 studies. **Phase 4** (Critical analysis of the included studies): After reading the full articles, implementing the exclusion criteria, inclusion criteria, and PICO strategy, 27 studies that did not align with the proposed theme were excluded (PubMed N=3, BVS (Lilacs) N=14, and BVS (Medline) N=10). **Phase 5** (Discussion of the results): The discussion among the authors regarding the proposed results from the samples was conducted by cross-referencing them with the guiding question: PubMed N=7, BVS (Lilacs) N=6, and BVS (Medline) N=2. **Phase 6** (Inclusion of samples in the review): Through a general analysis, 15 studies were included in this systematic review (PubMed N=7, BVS (Lilacs) N=6, and BVS (Medline) N=2).

Results and Discussion

Through the search in the PubMed and BVS (Lilacs) databases, a total of 321 articles related to stroke and its clinical correlation with cerebral aneurysm were identified. After applying the inclusion and exclusion criteria, 15 articles relevant to the research proposal were included. The synthesis process of this review aims to address the clinical implications of the disease and its related outcomes, which are discussed by the authors.

Table 1. Health Sciences Descriptors (DeCS MeSH)

ENGLISH	PORTUGUÊS	ESPAÑOL
Aneurysm	Aneurisma	Aneurisma
Artery	Artéria	Artería
Intracranial hemorrhagic	Hemorragia intracranial	Hemorragia intracranial
Stroke	Acidente vascular cerebral	Accidente cerebrovascular

Table 2. The PRISMA Statement.

P	Patients/Population	Individuals diagnosed with intracranial hemorrhagic stroke resulting from cerebral aneurysm.
I	Intervention/Exposure	Not applicable
C	Comparison/Control	Not applicable
O	Outcome/Result	Evaluation of clinical complications and outcomes related to hemorrhagic stroke associated with intracranial aneurysm.

Table 4. Demographic and Epidemiological Profile of Analyzed Patients

VARIABLE	CATEGORY	N	%
GENDER:	Female	12	55.5
	Male	10	44.5
GENERAL AGE RANGE	59.5 ± 16.0	22	100
COMORBIDITIES:	Hypertension	10	45.0
	Chronic heart disease	03	13.6
	Chronic kidney disease	01	4.5
	Diabetes Mellitus	02	9.1
	Atrial fibrillation	03	13.6
	No comorbidities	12	54.4

Source: Study by Sweid et al., 2020.

Table 5. Sociodemographic Profile of Patients with Cerebral Aneurysm

VARIABLE	CATEGORY	N	%
GENDER:	Female	38	74.51
	Male	13	25.49
AGE RANGE:	< 40 years	5	9.80
	40 to 50 years	16	31.37
	51 to 60 years	18	35.30
	> 60 years	12	23.53

Source: Study by Isaias et al., 2018.

Table 3. Review of the main articles included in the study.

Author and Year	Title	Objective	Journal	Results	Conclusion
Bai, Q., et al. (2020)	Microglia and macrophage phenotypes in intracerebral hemorrhage injury: therapeutic opportunities	To explore the phenotypes of microglia and macrophages in intracerebral hemorrhage and their therapeutic potential.	Brain	Identified distinct phenotypes of microglia and macrophages that influence hemorrhage outcomes.	Targeting specific phenotypes of microglia and macrophages can offer new therapeutic approaches for intracerebral hemorrhage.
Beltrán-Rodríguez, I., et al. (2020)	AVC vertebrobasilar: registro de tempos de atendimento e fatores relacionados ao atendimento precoce	To analyze the time metrics and factors related to early care in vertebrobasilar stroke.	Rev Neurol	Found that early recognition and treatment significantly affect outcomes in vertebrobasilar stroke.	Emphasizes the importance of timely intervention in improving stroke outcomes.
Bugge, H. F., et al. (2022)	Protocolo de estudo paramédico norueguês Acute Stroke Prehospital Project (ParaNASPP)	To evaluate the effectiveness of using the NIH Stroke Scale in ambulances for prehospital stroke triage.	Trials	Demonstrated that paramedics could effectively use the NIH Stroke Scale to improve prehospital stroke diagnosis and management.	Supports the implementation of NIH Stroke Scale training for paramedics to enhance prehospital stroke care.
Colton, K., et al. (2020)	Reconhecimento precoce de acidente vascular cerebral e métricas de desempenho de atendimento de emergência baseadas no tempo para hemorragia intracerebral	To assess early stroke recognition and emergency response time metrics for intracerebral hemorrhage.	J Stroke Cerebrovasc Dis	Early recognition and timely emergency response significantly improve outcomes for intracerebral hemorrhage patients.	Reinforces the critical role of rapid emergency response in managing intracerebral hemorrhage.
Gathier, C. S., et al. (2018)	Induced Hypertension for Delayed Cerebral Ischemia After Aneurysmal Subarachnoid Hemorrhage: A Randomized Clinical Trial	To investigate the effectiveness of induced hypertension in preventing delayed cerebral ischemia after subarachnoid hemorrhage.	Stroke	Induced hypertension was found to be effective in reducing the incidence of delayed cerebral ischemia.	Induced hypertension can be a viable treatment strategy for managing delayed cerebral ischemia post-subarachnoid hemorrhage.
Gorelick, P. B. (2019)	The global burden of stroke: persistent and disabling	To discuss the persistent and disabling global burden of stroke.	Lancet Neurology	Highlighted the significant and ongoing global impact of stroke on health and disability.	Urges for enhanced global stroke prevention and management strategies to address this persistent health burden.
Isaias, L. C. S., et al. (2018)	Evolução Clínica de Pacientes com Aneurisma Cerebral Internados em um Hospital Público	To analyze the clinical progression of patients with cerebral aneurysms in a public hospital.	Revista Interdisciplinar De Estudos Em Saúde	Provided data on patient outcomes and factors influencing clinical progression in cerebral aneurysm cases.	Indicates the need for specialized care and monitoring to improve outcomes for aneurysm patients in public hospitals.
Knight-Greenfield, A., et al. (2019)	Causes of Acute Stroke: A Patterned Approach	To examine the various causes of acute stroke using a patterned diagnostic approach.	Radiol Clin North Am	Identified distinct patterns in the causes of acute stroke, aiding in more accurate diagnosis and treatment.	A patterned approach can enhance the diagnostic accuracy and treatment efficacy for acute stroke.
Kumar, A. M., et al. (2023)	Hemorrhagic Stroke	To provide a comprehensive review of hemorrhagic stroke, its causes, and management.	StatPearls	Detailed the pathophysiology, causes, and treatment options for hemorrhagic stroke.	Highlights the complexity of hemorrhagic stroke management and the need for tailored therapeutic strategies.
Lobo, P., et al. (2021)	Epidemiologia do acidente vascular cerebral isquêmico no Brasil no ano de 2019, uma análise sob a perspectiva da faixa etária	To analyze the epidemiology of ischemic stroke in Brazil in 2019 across different age groups.	Brazilian Journals	Revealed age-specific trends and risk factors for ischemic stroke in Brazil.	Provides insights into targeted stroke prevention and treatment strategies based on age demographics.
Mendes, D., et al. (2018)	Characterization of aphasia in aneurysmal subarachnoid hemorrhage	To characterize aphasia outcomes in patients with aneurysmal subarachnoid hemorrhage.	CoDAS	Found that aphasia is a common outcome in these patients, requiring specialized speech and language therapy.	Emphasizes the need for early and tailored aphasia intervention in aneurysmal subarachnoid hemorrhage patients.
Paliwal, P. R., et al. (2020)	Impacto da pandemia de COVID-19 no tratamento de AVC hiperagudo: experiência de um centro abrangente de AVC em Cingapura	To evaluate the impact of the COVID-19 pandemic on hyperacute stroke treatment.	J Thromb Thrombolysis	COVID-19 pandemic significantly disrupted stroke treatment protocols, leading to delays and altered care pathways.	Highlights the necessity for adaptable stroke care protocols during global health crises like the COVID-19 pandemic.
Peng, et al. (2022)	Long-Term Survival, Stroke Recurrence, and Life Expectancy After an Acute Stroke in Australia and New Zealand From 2008–2017: A Population-Wide Cohort Study	To study long-term outcomes, recurrence, and life expectancy after acute stroke.	Stroke	Provided comprehensive data on survival rates, recurrence, and life expectancy post-stroke.	Long-term monitoring and intervention are crucial for improving life expectancy and reducing recurrence after an acute stroke.
Shkirkova, K., et al. (2020)	Impressão global do paramédico da mudança durante a avaliação pré-hospitalar e transporte para acidente vascular cerebral agudo	To assess paramedics' impressions and decision-making during pre-hospital stroke assessment and transport.	Stroke	Paramedics' assessments significantly impact pre-hospital stroke care and subsequent treatment outcomes.	Enhances the understanding of pre-hospital stroke assessment's role in improving overall stroke care quality.
Silva, J. V. B., et al. (2024)	The Amplified Effects of Covid-19: Analysis of Health Risks and	To analyze the amplified health risks and socio-	Revista de Gestão Social e Ambiental	COVID-19 pandemic exacerbated existing health	Calls for integrated global health and socio-economic

In 2019, the Global Burden of Diseases (GBD) Study, led by Feigin and colleagues, compiled global data on stroke. According to the study, 12.2 million new cases of stroke were recorded worldwide, resulting in 6.55 million deaths related to the disease. These numbers highlight the significant global burden of stroke as a leading cause of morbidity and mortality. Complementing this, the Brazilian Stroke Society (SBAVC) provides scientific data, describing an annual rate of intracerebral hemorrhage—hemorrhagic stroke due to ruptured cerebral aneurysms—of about 8 to 10 cases per 100,000 people.

In 2020, the World Health Organization (WHO) declared the COVID-19 (SARS-CoV-2) pandemic, which resulted in over 6.9 million deaths and nearly 700 million confirmed cases worldwide up to that point. Consequently, many vascular complications arose due to COVID-19 infection. Silva et al. (2024) conducted a retrospective study between May and March 2020, synthesizing a review of patients with acute cerebrovascular disease and diagnosed with coronavirus. The sample included 22 patients, with cerebrovascular pathologies consisting of 17 cases of acute ischemic stroke, 3 cases of aneurysm rupture, and 2 cases of sinus thrombosis.

The article concludes that COVID-19 patients who suffer a stroke associated with large vessel occlusion (LVO) have a high mortality rate despite receiving appropriate treatment. Therefore, the COVID-19 virus can create an environment that favors clot formation and inhibits neuroprotective factors, worsening the clinical condition.

The Australian study by Peng et al. (2022), conducted with adults hospitalized for strokes between 2008 and 2017, tracked over 313,000 stroke victims for 10 years in Australia and New Zealand. It revealed concerning information about the recurrence rate and survival of these patients. The results showed an overall stroke recurrence rate of 26% over 10 years, indicating that the occurrence of a new stroke after the first event is relatively high. Additionally, the survival rate after 5 years was 52%, meaning that just over half of the patients survived this period after the first stroke. However, 10 years after the first stroke, the survival rate dropped even further, reaching only 36%, indicating that the disease is associated with a significant loss of life expectancy.

According to a prospective study by Isaias et al. (2018), which evaluated 51 patients of both sexes diagnosed with cerebral aneurysm and admitted to a neurological ward between July and October 2017, ages ranged from 24 to 77 years, with 38 (74.51%) being female, with a mean age of 53.45 years, ± 11.78 . The age group between 51 and 60 years was the most affected, representing 35.30%, as shown in Table 3.

The study indicates a higher percentage of individuals affected by aneurysm among males, where 74.51% of the cases (38) are represented by men and 25.49% (13) by women. The study

correlates these data with factors such as uncontrolled hypertension and smoking, which are more prevalent among men and represent direct risk factors for aneurysm development.

The clinical manifestations of aneurysmal stroke can vary among patients, but they are usually presented as a headache with a pain scale of 10/10, hemiparesis, aphasia, partial or total loss of the visual field, tingling sensations in the face, upper and lower limbs, and in some cases, drowsiness and coma (Zhen Xu et al., 2019). The main risk factors for developing a cerebral aneurysm include advanced age, smoking, dyslipidemia, excessive alcohol consumption, and primarily systemic arterial hypertension (Kumar, 2023).

Aneurysm ruptures are responsible for 85% of subarachnoid hemorrhage cases and are associated with new stroke cases, according to a longitudinal study by Cunha et al. (2018). The study aimed to analyze the clinical progression of patients with cerebral aneurysm hospitalized and concluded that hemiplegia was the most common motor deficit upon admission. Additionally, the mortality outcome represented 11.76% of hospitalizations, with an average hospital stay of 20.1 days.

In a retrospective study (Mendes et al., 2018) conducted at the Hospital da Restauração in the state of Pernambuco, medical records of 193 patients with aneurysmal subarachnoid hemorrhage (SAH) were analyzed with an emphasis on aphasia, selecting 26 under the criterion that the affected arterial branches are responsible for irrigating the eloquent areas of brain function. The study concluded that subarachnoid hemorrhage in patients with aneurysm in the left middle cerebral artery causes linguistic-cognitive impairments, observing reductions in both language performance and verbal fluency.

Furthermore, a retrospective study by Marvin et al. (2022) evaluated the medical records of 690 patients diagnosed with aneurysmal subarachnoid hemorrhage (aSAH) to elucidate the impact of different blood pressure values during the acute phase of aSAH on the outcome. The study concluded that a mean arterial pressure (MAP) exceeding the intended values without iatrogenic intervention could worsen the autoregulatory mechanisms against impending cerebral ischemia in patients with cerebral vasospasm. Additionally, according to Gathir et al. (2018), a higher MAP has been associated with increased cardiac and renal complications, especially if caused iatrogenically in the acute phase of aSAH.

Conclusion

This review provides an understanding of the probable clinical complications of hemorrhagic stroke resulting from cerebral aneurysm and correlates this diagnosis with aspects that contribute to the occurrence of this condition, highlighting the main consequences that may arise. The main risk factors for developing an aneurysm are associated with advanced age, smoking, dyslipidemia, alcohol consumption, and primarily systemic arterial hypertension. However, further studies in this area are essential to

expand scientific knowledge about this pathology and offer professionals evidence to support more precise treatments. Therefore, conducting new research in this field is suggested.

Author contributions

E.N.N. conceived the study design, developed the research methodology, and was responsible for data analysis and interpretation. J.V.B.D.S. contributed to the literature review, assisted in data collection, and provided critical revisions to the manuscript. W.B.S. managed data entry, performed statistical analyses, and wrote the initial draft of the manuscript. E.E.T.F. offered substantial input on the study's theoretical framework and reviewed the final manuscript. P.S.A.M. assisted in data collection and analysis and provided critical revisions. J.H.M.L. supervised the project, coordinated the research activities, and ensured the accuracy of the final manuscript. All authors reviewed and approved the final version of the manuscript.

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Competing financial interests

The authors have no conflict of interest.

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