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### Keywords

Subarachnoid Hemorrhage  
Aneurysm  
Middle Cerebral Artery  
Disorders of Language  
Aphasia

### Descritores

Hemorragia Subaracnoide  
Aneurisma  
Artéria Cerebral Média  
Transtornos da Linguagem  
Afasia

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Received: March 01, 2017

Accepted: September 02, 2017

# Characterization of aphasia in aneurysmal subarachnoid hemorrhage

## *Caracterização das afasias na hemorragia subaracnóidea aneurismática*

### ABSTRACT

**Purpose:** Characterize the profile of aphasic syndromes determined by aneurysmal subarachnoid hemorrhage (aSAH) of the left middle cerebral artery (LMCA). **Methods:** An analytical, retrospective, cross-sectional study was conducted using a database of cognitive assessments of 193 patients with aSAH admitted to Hospital da Restauração between March 2007 and November 2009. Of these, a total of 26 patients with aSAH in the LMCA territory confirmed by digital angiography were selected. Aphasia was assessed through the Montreal-Toulouse Language Assessment Alpha Version Protocol (Alpha Version) and the CERAD Neuropsychological Test Battery (Verbal fluency). **Results:** Language and verbal fluency impairments were identified in patients with aSAH in the LMCA territory when compared with the control population (50 individuals). Of the 26 patients with aSAH, 11 presented aphasic characteristics preoperatively. **Conclusion:** The results of this research corroborate the literature, showing that the aSAH frame causes cognitive impairments even in the preoperative phase for aneurysm occlusion. Considering the observed aspects, the predominant aphasic syndromes characterize comprehension aphasia due to sequels in the posterior cerebral artery territory.

### RESUMO

**Objetivo:** Caracterizar o perfil dos quadros afásicos determinados pela hemorragia subaracnóidea aneurismática (HSA) da artéria cerebral média esquerda. **Método:** Estudo analítico, retrospectivo, transversal, tendo como banco de dados as avaliações cognitivas de 193 pacientes do Hospital da Restauração com HSA aneurismática no período de março de 2007 a novembro de 2009. Destes, foram selecionados 26 pacientes com HSA em território da ACM-E, confirmada por angiografia digital. Os quadros afásicos foram classificados através do desempenho da linguagem dos pacientes através do Protocolo Montreal-Toulouse (Versão Alpha) e a tarefa de fluência verbal da bateria CERAD. A pesquisa foi realizada no período de junho a agosto de 2015. **Resultados:** Foi identificado comprometimento da linguagem e fluência verbal nos pacientes com HSA em território de ACM-E quando comparados com a população controle (50 indivíduos). Dos 26 pacientes com HSA, 11 apresentaram quadros afásicos ainda no período pré-operatório. **Conclusão:** Os resultados da pesquisa corroboram com a literatura, mostrando que o quadro da HSA promove comprometimentos cognitivos ainda na fase pré-operatória para oclusão de aneurisma. Tendo em vista os aspectos observados, os quadros afásicos predominantes caracterizam afasia de compreensão por sequelas nas áreas cerebrais posteriores.

Study carried out at Departamento de Fonoaudiologia, Universidade Federal de Pernambuco – UFPE - Recife (PE), Brazil.

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**Financial support:** nothing to declare.

**Conflict of interests:** nothing to declare.



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## INTRODUCTION

Cerebrovascular diseases are the third cause of mortality in Brazil, most of them associated with stroke, which are classified as ischemic or hemorrhagic<sup>(1)</sup>.

Hemorrhagic stroke can occur in several spaces: brain, brain stem (intraparenchymal hemorrhagic stroke), or meninges, and can reach the arachnoid membrane, resulting in a subarachnoid hemorrhage (SAH), which accounts for 5-10% of all cases of stroke<sup>(2)</sup>. For some authors, there is no relation between localization of brain aneurysm and cognitive impairment; however, others specify and associate cognitive deficits with this localization<sup>(3)</sup>.

The main etiology of SAH consists in the rupture of saccular aneurysms<sup>(4-6)</sup>, which are mostly situated in the arteries of the polygon of Willis<sup>(7)</sup>, which is defined as an

[...] arterial anastomosis that provides blood flow to the cerebral hemispheres, and is composed of the anterior and posterior cerebral arteries, anterior and posterior communicating arteries, and the internal carotid<sup>(8:170)</sup>.

Aneurysmal SAH (aSAH) can be diagnosed by complementary exams such as computed tomography (CT) without contrast, in which the presence of SAH is detected with the appearance of a hyperdense area, revealing blood leakage in the basal cistern<sup>(9)</sup>. After confirmation of hemorrhage by CT, conventional angiography should be performed - which is considered the gold standard examination for detecting saccular aneurysms and the most appropriate one to diagnose the causes of non-traumatic SAH<sup>(10)</sup>.

The prognosis of SAH depends on several factors: initial blood volume in the subarachnoid space, presence of new bleeding, and other neurological complications such as delayed cerebral ischemia, hydrocephalus, and cerebral vasospasm<sup>(11)</sup>. To measure the volume of blood in the subarachnoid space, the Fisher Grading Scale was developed, which correlates the amount of blood identified in the CT with development of vasospasm. This scale comprises four distinct groups (I to IV), with Grade III as the most closely associated with the presence of clinical and angiographic vasospasm<sup>(7)</sup>.

Cognitive changes are one of the main consequences of aSAH. Studies confirm that 30-55% of patients with aSAH present severe or at least marked deficits in one or more functions of the cognitive domain postoperatively<sup>(12)</sup>. Although cognitive changes represent an important clinical problem, little is still known about the factors that cause these impairments in aSAH.

Due to the need to treat aSAH as early as possible, many authors describe the presence of cognitive impairment postoperatively to aneurysm occlusion<sup>(13,14)</sup>. For this reason, it is not possible to establish whether the damage was caused by the aSAH or by the surgical or endovascular procedures.

Another unclear point about aSAH is the doubt regarding the presence of cognitive impairment associated with localization of the aneurysm. Some authors claim that there is no correlation between these two aspects<sup>(8,15,16)</sup>, whereas others state the opposite<sup>(17)</sup>.

In the Brazilian health system, the procedure for aneurysm occlusion, avoiding rebleeding, is not always performed in the first days after aSAH. Because of factors such as difficulty in

diagnosing, distance from specialized neurosurgical centers, and overcrowding of hospitals, the procedure for aneurysm occlusion can take several days to be performed<sup>(18)</sup>. In this context, it is possible to evaluate the patient preoperatively, enabling identification of cognitive damage resulting from aSAH itself. Until the publication by Vieira et al.<sup>(19)</sup>, the literature did not present studies measuring cognitive skills preoperatively to aneurysm occlusion and, therefore, it was not possible to characterize damages determined by aSAH itself.

Among the cognitive changes, language impairment resulting in aphasia can drastically compromise patients' quality of life<sup>(20)</sup>.

Aphasia is the loss or impairment of language function caused by brain injury; it involves the ability to interpret and formulate meaningful linguistic elements<sup>(21:39)</sup>.

As aphasia can have its classification determined by the injured area, and because it presents characteristics that can be identified from bedside assessment instruments, this study aimed to characterize the presence of aphasic syndromes in patients with aSAH in the left middle cerebral artery (LMCA) territory preoperatively. In this way, it will be possible to understand the damages in language function caused by aSAH and the influence of aneurysm localization in this function.

## METHODS

The present study was conducted at Hospital da Restauração, which is the largest emergency hospital in the state of Pernambuco and has offered a high-complexity care service in neurosurgery since 1976.

Individuals with subarachnoid hemorrhage (SAH) caused by aneurysm in the left middle cerebral artery (LMCA) territory admitted to the Hospital were included in the study. Exclusion criteria were as follows: patients with aneurysmal subarachnoid hemorrhage (aSAH) in other anterior cerebral circulation territories and individuals aged over 75 years.

This is an analytical, retrospective, cross-sectional study conducted using a database of cognitive assessments of 193 patients with aSAH in anterior cerebral circulation territories admitted to the emergency room of Hospital da Restauração between March 2007 and November 2009. Of these, a total of 26 patients with aSAH in the LMCA territory confirmed by digital angiography were selected. The choice of this group is justified by the fact that this artery irrigates the language functional eloquent brain regions<sup>(22,23)</sup>. Data collection was performed through secondary data obtained from a previous research<sup>(18)</sup> which enabled the characterization of aphasia in the assessed individuals in comparison with a control group.

Initially, the individuals underwent computed tomography (CT) scan and/or cerebrospinal fluid (CSF) examination, with confirmation of aneurysm by angiography and diagnosis of aSAH. They were then interviewed and evaluated with respect to language functions in a period of at least eight days after the onset of SAH.

Language assessment was performed by the speech-language therapist (ACCV) of the Neurosurgery Department of Hospital da Restauração at the Center for Interdisciplinary Care in

Neurosurgery (NAIN). The evaluation consisted of an interview with the patients and their relatives and application of the Montreal-Toulouse Language Assessment Protocol (Alpha version) and the CERAD Neuropsychological Test Battery (Verbal fluency). The Protocol was first used in Brazil in a multicenter study conducted with individuals from Pernambuco state by Lecours et al.<sup>(24)</sup>. Thus the Protocol presents characteristics that fit the reality of this population, such as regional matters and schooling.

Data from the language assessment of each patient performed in the initial study were organized, and the characteristics and profiles of aphasia were confirmed according to the Boston classification. Only 26 of the initial 193 patients presented aSAH in the LMCA territory confirmed by digital angiography. The control sample was composed of individuals in the same age range - for convenience, they were relatives and/or companions of the patients, matched for age, schooling, and gender.

Data were analyzed using the SPSS 13.0 software for Windows and Excel 2003. All tests were applied with 95% confidence level. The Kolmogorov-Smirnov test was applied to verify the normality of the quantitative variables. The Student t-test (Normal distribution) and the Mann-Whitney test (Non-normal distribution) were used for the analysis of the two groups. The paired Student t-test was used when the distribution was normal and the Wilcoxon test was applied for non-normal distribution when the same group was analyzed in two moments (pre- and post-operatively).

The present research followed the ethical precepts established in resolution 466/12 of the Conselho Nacional de Saúde, and it was

approved by the Research Ethics Committee of the aforementioned Institution. The realization of this study did not interfere with the treatment offered to the patients, considering that its objective was to analyze previously obtained data. All participants signed an Informed Consent Form (ICF) prior to study commencement.

## RESULTS

Aiming to characterize aphasia in aneurysmal subarachnoid hemorrhage (aSAH), 26 patients with ruptured aneurysm in the left middle cerebral artery (LMCA) territory were selected for this study. The performance in the tasks of language and verbal fluency and memory of these patients was compared with that of individuals of a control group. The results were statistically analyzed through the Student t-test (Normal distribution) and the Mann-Whitney test (Non-normal distribution) and are presented in the tables and graph included in this manuscript.

Table 1 shows that the performance in all language functions of the patients with SAH caused by rupture of aneurism in the LMCA was poorer compared with that of individuals in the control group. Only the function of repetition did not present statistically significant difference ( $p=0.086$ ) between the groups. Evident decrease in the performance of patients with aSAH was observed for the tasks of verbal fluency and memory.

Table 2 presents an analysis of the performance in language and verbal fluency of each patient with aSAH in the LMCA territory. Of the 26 patients investigated, 11 presented profiles characteristic of aphasic syndromes. The individuals were

**Table 1.** Performance in the Montreal-Toulouse Language Assessment Protocol of individuals with aSAH in the left middle cerebral artery (LMCA) preoperatively and the control group

Variables	Type		p-value
	CONTROL (N=50)	LMCA (N=26)	
	Mean ± SD	Mean ± SD	
Auditory comprehension (max. score=11)	9.66 ± 1.255	7.69 ± 3.185	<b>0.012*</b>
Repetition (max. score=11)	10.08 ± 0.804	8.54 ± 3.101	0.086*
Naming (max. score=12)	11.48 ± 0.579	8.85 ± 4.397	<b>0.026*</b>
Written comprehension (max. score=11)	10.53 ± 0.772	8.31 ± 3.198	<b>0.005*</b>
Oral reading (max. score=11)	10.89 ± 0.459	9.25 ± 2.978	<b>0.044*</b>
Semantic verbal fluency	17.76 ± 4.979	8.73 ± 5.668	<b>&lt; 0.0001*</b>
Phonological fluency	14.68 ± 4.623	8.60 ± 4.641	<b>0.0014*</b>
Verbal memory	19.04 ± 3.736	11.45 ± 3.502	<b>&lt; 0.0001*</b>

\*Mann-Whitney test

**Table 2.** Characterization of the aphasic frames

Participants	Gender	Age	Schooling	Dominance	Fisher	Aphasia
1	M	56	0	D	III	Transcortical Sensory
2	M	61	8	D	III	Acquired dyslexia
3	M	73	0	D	IV	Transcortical Sensory
4	F	55	0	D	IV	Wernicke's
5	F	41	5	D	III	Anomic
6	F	69	0	D	-	Transcortical Sensory
7	F	55	1	D	III	Wernicke's
8	F	38	5	D	IV	Transcortical Sensory
9	F	43	4	D	IV	Transcortical Sensory
10	F	51	-	D	III	Global
11	F	63	0	D	-	Transcortical Sensory

**Caption:** Fisher: Fisher Grading Scale; D: dextral

predominantly female (72%), aged 30-50 years (27%) and older than 50 years (72%). Seven were illiterate and five had one to eight years of schooling. All participants were dextral. Five patients (45%) presented grade III and four patients (36%) had grade IV on the Fisher scale; the scores of two patients were not found in their medical records. Predominance of aphasic frames was transcortical sensory aphasia with 41.6% followed

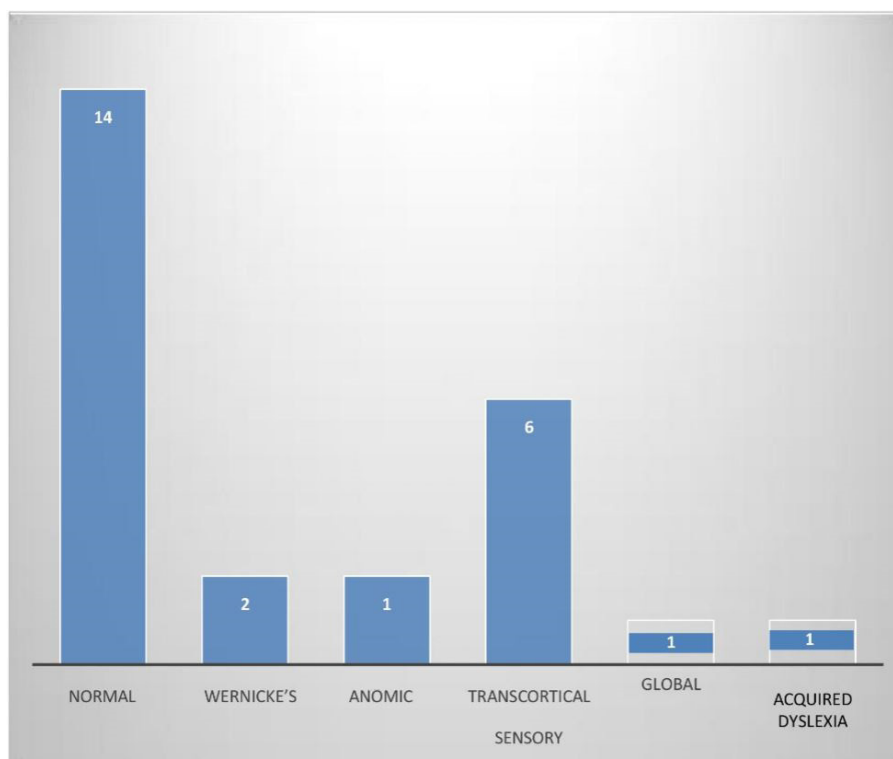
by Wernicke's aphasia with 16.6%. Table 3 shows the semiology of the aphasic frames.

Graph 1 depicts the numerical details of the types of aphasia. Of the 11 patients with aphasic syndrome, six had transcortical sensory aphasia, two presented Wernicke's aphasia, one had anomic aphasia, one presented global aphasia, and there was one case of acquired dyslexia without major impairment in oral language.

**Table 3.** Semiology of the aphasic frames

PATIENT	AGE	SPEECH	AUDITORY COMPREHENSION	REPETITION	NAMING	PARAPHASIA	PERSEVERATION	PERIPHRASES	JARGON	SEMANTIC FLUENCY ANIMALS	SEMANTIC FLUENCY FRUITS	APHASIA
1	56	F	Dimin.	Adeq.	Good	Y	N	Y	N	11	8	TCS
2	61	F	Adeq.	Adeq.	Good	Y	N	N	N	14	10	AD
3	63	F	Dimin.	Adeq.	Good	Y	Y	N	N	0	0	TCS
4	55	F and Inc.	Poor	Absent	Absent	Y	Y	N	Y	1	2	W
5	41	F	Adeq.	Adeq.	Adeq.	N	N	Y	N	10	11	A
6	69	F	Poor	Adeq.	Good	N	N	N	N	9	3	TCS
7	55	F and Inc.	Poor	Dimin.	Dimin.	Y	Y	N	Y	0	0	W
8	38	F and Inc.	Poor	Adeq.	Absent	Y	Y	N	N	0	0	TCS
9	43	F	Poor	Adeq.	Absent	Y	N	N	Y	0	0	TCS
10	51	NF	Poor	Absent	Absent	Y	Y	N	N	0	0	GL
11	63	F and Inc.	Poor	Adeq.	Poor	Y	Y	N	Y	4	0	TCS

**Caption:** F: Fluent; Inc.: Incoherent; NF: Non-fluent; Y: Yes; N: No; TCS: Transcortical sensory; AD: Acquired Dyslexia; W: Wernicke's; AN: Anomic; GL: Global; Dimin.: Diminished; Adeq.: Adequate



**Graph 1.** Types of aphasia

## DISCUSSION

This study aimed to understand the language impairments cause by aneurysmal subarachnoid hemorrhage (aSAH) of the left middle cerebral artery (LMCA) and characterize the possible aphasic syndromes resulting exclusively from SAH, without the interference of procedures conducted to treat the aneurism. This survey intended to provide the scientific community with a better understanding on the possible language impairments that occur as a consequence of aSAH preoperatively and of the influence of aneurysm localization on cognitive functions, such as language performance with characterization of aphasic frames.

Classifying a linguistic-cognitive impairment presents several challenges because the influence of cognitive functions on language is quite evident in certain tests. The rater is responsible for classifying which functions may have influenced the result<sup>(20)</sup>. Thus the choice of material to evaluate an illiterate population is primordial. In this study, the Montreal-Toulouse Language Assessment Protocol (Alpha version) was in line with our objectives, because it presents characteristics that were in agreement with the reality of our sample, which comprised a significant number of illiterates.

Comparison between the patients with aSAH in the LMCA territory and the individuals in the control group showed reduction in language performance in most tasks, except for repetition, demonstrating that the language function was affected preoperatively in these patients. As the control group was composed of individuals from the same environment as that of the patients, mainly relatives who had similar schooling and sociocultural levels, it was difficult to justify impairments in these functions that were not due to losses resulting from aSAH.

Of the 26 patients with aSAH in the LMCA territory, 14 did not present low performance in the language tasks that characterized aphasic syndromes. The scores of these patients in the Fisher scale were predominantly grade I and II. This finding confirms that not all individuals with SAH present linguistic-cognitive impairments, which may be justified by a smaller volume of blood in the subarachnoid space determined by the Fisher grading scale scores of these patients. As for the 11 patients that presented language impairment, the scores in the Fisher scale were predominantly grade III and IV. These data corroborate the study by Souza et al.<sup>(25)</sup>, who reported that as the blood volume increases in the subarachnoid cavity, a decline is observed in the cognitive functions of the patient, specifically, the language function is compromised. According to the Fisher scale, grade III is associated with increased risk of vasospasm and ischemia - factors that may lead to greater cognitive impairment<sup>(7)</sup>.

Statistically significant differences in the verbal fluency tasks were observed between the patients with aSAH in the LMCA territory and the individuals in the control group. Although some patients in the SAH group did not present aphasic characteristics, the poor performance of patients with aphasia promoted a decrease in the mean of this group. This poor verbal fluency performance corroborates the findings of a recent study that showed a decrease in the performance of aphasic individuals

compared with that of a control group in the tasks of verbal fluency and memory<sup>(26)</sup>.

The aphasia frames observed in this study show a relevant number of cases of transcortical sensory aphasia. Assessment of these patients showed a poor level of auditory comprehension. In some cases, the speech presented constancy of aphasic characteristics, such as paraphasia, jargon, and perseveration; however, repetition was preserved in all cases. In this sample, when individuals with SAH in the LMCA were compared with those of the control group, repetition was the only task that did not present statistically significant differences. This finding demonstrates that, even though aphasia occurs in the group with aSAH in the LMCA, there is predominance of non-central aphasia, which presents the repetition task preserved<sup>(27)</sup>.

Only three of the 11 aphasic patients presented impairment of the repetition task: two with Wernicke's aphasia and one with global aphasia. The two patients with Wernicke's aphasia presented grade IV in the Fisher scale, that is, the maximum blood volume score in the subarachnoid space, which is indicative of greater cognitive impairment<sup>(25)</sup>.

In a study<sup>(28)</sup> whose findings confirmed a larger number of cases of aneurysm in the first temporal branches (identified in more than 90% of the cases), the verified results corroborate those demonstrated in the present research, because of the 11 patients with aphasia, six had transcortical sensory aphasia, two presented Wernicke's aphasia, and one had acquired dyslexia, which characterizes the posterior arm of the middle cerebral artery as a locus of characteristics of aphasic syndromes associated with the temporoparietal region.

## CONCLUSION

Subarachnoid hemorrhage in patients with aneurism in the left middle cerebral artery territory causes linguistic-cognitive impairments preoperatively to aneurism occlusion. Reduction in language performance and verbal fluency was observed in the comparison between the groups. Posterior aphasia was predominant among the aphasic frames. The amount of blood in the subarachnoid space may cause greater language impairment. Localization of aneurysm suggests that it occurs in the temporal branch of the M1 segment.

Considering the aspects observed in relation to the Fisher scale, the varying grades present different levels of language impairment. The greater the volume of blood in the subarachnoid space, the greater the predicted language impairment preoperatively to aneurysm occlusion.

Based on the previously mentioned facts, further studies associating aneurysm localization with aphasic syndromes are needed. In addition, a better understanding of health professionals about the cognitive changes caused by aneurysmal subarachnoid hemorrhage is expected.

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#### Author contributions

*DKMM, MLPS, MLGC, and ACCV* were responsible for the study design and equally participated in the analysis of data and writing of the manuscript.