



# Fisher Grading Scale and Cognitive Deficits — Literature Review

## *Escala de Fisher e déficits cognitivos — Revisão da literatura*

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### Abstract

Subarachnoid hemorrhage (SAH) accounts for 5 to 10% of all types of stroke, with rupture of brain aneurysms being related to deficits in memory, executive functions, and language. Changes in brain functions appear to be related to the presence of blood in the subarachnoid space, and the Fisher Scale (FS) correlates the amount of blood identified on computed tomography (CT). This paper presents a literature review of the association of FS with cognitive deficits secondary to aneurysmal subarachnoid hemorrhage (aSAH), using PubMed. The attempt to correlate the amount of blood identified in the CT with the development of cognitive alterations presents conflicting data. It was evidenced that some of the studies did not perform cognitive tests, or did not show differences between the scores of FS due to sample difficulty. The FS, even with its limitations and imperfections, seems to be a safe and easily reproducible way to predict neurological, cognitive or neuropsychological deficits, in view of its routine use when analyzing patients with aSAH.

### Keywords

- ▶ intracranial aneurysm
- ▶ cognitive dysfunction
- ▶ subarachnoid hemorrhage
- ▶ tomography

### Resumo

Hemorragia subaracnóidea (HSA) representa de 5 a 10% de todos os tipos de acidente vascular encefálico, estando a ruptura de aneurismas cerebrais relacionada a déficits na memória, nas funções executivas e na linguagem. As alterações nas funções cerebrais parecem estar relacionadas à presença de sangue no espaço subaracnóideo, sendo a escala de Fisher (EF) a forma de mensuração do conteúdo hemático, realizada através de tomografia computadorizada (TC). O presente artigo apresenta uma revisão da literatura sobre a associação da EF com déficits cognitivos secundários a HSA aneurismática (HSAa), tendo como banco de dados para a pesquisa o PubMed. A tentativa de correlacionar a quantidade de sangue identificada na TC de crânio com o desenvolvimento de alterações cognitivas apresenta dados bastante conflitantes, evidenciando que alguns dos trabalhos não realizaram testes cognitivos, ou não demonstraram diferenças entre os graus da EF por dificuldade na amostragem. A EF, mesmo com suas limitações e imperfeições, parece ser uma forma segura e de fácil reprodutibilidade para prever déficits neurológicos, cognitivos ou neuropsicológicos, tendo em vista o seu uso rotineiro na análise de pacientes com HSAa.

### Palavras-chave

- ▶ aneurisma intracraniano
- ▶ disfunção cognitiva
- ▶ hemorragia subaracnóidea
- ▶ tomografia

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## Introduction

Subarachnoid hemorrhage (HSA) represents 5 to 10% of all types of cerebrovascular accidents, affecting mainly women in the 5<sup>th</sup> decade of life.<sup>1,2</sup>

The main surgical treatment options for cerebral aneurysms are microsurgery with clipping and the endovascular technique with embolization, using microcoils. Both aim to occlude the aneurysm, preventing the rebleeding and reducing the risk of complications.<sup>3</sup>

A review of the literature (61 studies) on cognitive evaluation and functional outcome of patients with aneurysmatic HSA (HSAa) revealed important deficits in memory (ranging from 14 to 61%), in executive functions (ranging from 3 to 76%), and in language (ranging from zero to 76%).<sup>4</sup>

Alteration in brain functions seem to be related to the presence of blood in the subarachnoid space.<sup>5</sup> The Fisher scale (FS) is the form of measurement of the hematic content, performed through computerized tomography (CT), which is the most used exam in neurosurgical practice.<sup>6</sup>

## Methodology

The present article presents a review of the literature on the association of FS with cognitive deficits secondary to HSAa. The bibliographic references were accessed in the PubMed database, using the following keywords: *Fisher scale*, *Fisher grade*, *subarachnoid hemorrhage*, *cognitive impairment*, *neuropsychological assessment*, *intracranial aneurysm* and *outcome*, with articles published in the last 20 years (1997–2016).

Thus, the present article aims to discuss aspects related to cognitive alterations and FS, performing a thorough analysis of the selected studies, and not focusing specifically in neuropsychological tests in the present review.

### Fisher Scale, Modified Fisher and Claassen

The FS subdivides patients with HSAa into four groups (→ **Table 1**), according to the distribution and amount of blood observed at CT performed after rupture of a cerebral aneurysm.

Despite being a globally widespread scale, the FS has several limitations: patients with higher scores do not have a higher risk of developing vasospasm, due to the greater involvement of Fisher 3<sup>6</sup>; it doesn't make the separation between patients with

cisternal HSA and intraventricular hemorrhage, a relevant factor for the development of vasospasm<sup>7–9</sup>; and it doesn't take into account the density and clearance rate of the clot.<sup>10,11</sup>

When we compared the FS with the modified Fisher<sup>12</sup> and Claassen scales,<sup>8</sup> we noticed an important difference in the absence of blood. In the FS, absence of blood is classified as Fisher 1, because this scale does not have a zero score, unlike the other two most current scales.

Another important disparity is the evaluation of intraventricular hemorrhage, considered Fisher 4 on the original scale. It may correspond to modified Fisher 2 or 4, depending on the thickness of the HSA.<sup>12</sup>

The Claassen scale<sup>8</sup> differentiates the involvement of both lateral ventricles or of only one of them, a fact not specified in the FS and modified Fisher. The presence of blood in the lateral ventricles (especially when it occurs bilaterally), but not in the 3<sup>rd</sup> or 4<sup>th</sup> ventricles, represents an important predictor of vasospasm.<sup>8</sup>

For these reasons, Kramer et al<sup>13</sup> compared the FS, the modified Fisher and the Claassen scales, evaluating the development of vasospasm and late infarction, evidencing that the increase in scores has a linear relationship in the last two, and that the FS Fisher 3 score is related to a higher incidence of vasospasm (35%).

In terms of mortality, 18% of patients with HSAa evolve to in-hospital death, the main causes being the direct effects of initial hemorrhage (55%) and of the aneurysm rebleeding (17%). As predictors of this mortality, we found: modified Fisher, age of the patient, presence of loss of consciousness in the ictus, Glasgow scale on admission, and size of the aneurysm.<sup>14</sup>

In relation to mortality after rebleeding, it is known that it is associated with higher scores of modified Fisher, as well as larger aneurysms and with worse assessments on the Glasgow scale after the new bleeding.<sup>15</sup>

Fisher scale and vasospasm/late cerebral infarction may be defined as a deterioration caused by vasospasm and/or an infarction related to vasospasm evidenced in CT that was not observed on admission or in the immediate postoperative CT.<sup>8</sup>

Approximately 60 to 70% of the patients with HSAa present with radiological vasospasm, two thirds of which present severe ischemic events that cause transient or permanent neurological deficits, configuring clinical or symptomatic vasospasm.<sup>16</sup>

Fisher et al<sup>6</sup> developed the main study that relates the location and amount of blood in the subarachnoid space with vasospasm development, finding a statistically significant correlation for Fisher 3 score (92% sensitivity, 95% specificity, 96% positive predictive value and 91% negative predictive value).<sup>6</sup>

The results of Hütter et al,<sup>17</sup> when comparing patients with minimal/mild HSAa (Fisher 1 and Fisher 2) with patients with moderate/severe HSAa (Fisher 3 and Fisher 4), showed that those with higher bleeding had worse assessments in relation to quality of life.

Considering that the presence of intraparenchymal blood and the hemoventriculum confers an additional risk to vasospasm development, it was proposed to create a new Fisher score 3 + 4, combining massive cisternal hemorrhage with

**Table 1** Fisher Scale for Aneurysmal Subarachnoid Hemorrhage

Score	Description
Fisher 1	No subarachnoid blood detected
Fisher 2	Diffuse bleeding with all < 1-mm thickness vertical layers (interhemispheric fissure, insular cisterna, cisterna ambiens)
Fisher 3	Localized clot (defined as 3 × 5 mm) or bleeding with 1-mm thickness vertical layer
Fisher 4	Intraventricular or intraparenchymatous clot, with or without diffuse subarachnoid hemorrhage.

intraventricular or intraparenchymal hematoma > 5 mL. Thus, the presence of vasospasm in 40% of the cases of Fisher 3 and in 68% of the Fisher 3 + 4 was evidenced.<sup>18</sup>

In recent years, the concept of clot clearance rate has emerged, and can be defined as the difference between the initial and final volumes of the clot (in mL), divided by the number of days<sup>11</sup>; or through the residual volume of the clot, which is the percentage between the measurements of the initial evaluation of the bleeding in relation to the analyses over the days after the HSAa.<sup>19</sup>

The lower the clot clearance rate, Fisher 3 score, the higher initial clot volume and the higher initial clot density correlate with the risk of developing vasospasm in univariate analyses. However, only the highest initial volume of the clot and the lowest daily clearance rate remain with statistical significance in multivariate analyses.<sup>11</sup>

However, only the highest initial bleeding volume is associated with late cerebral infarction, when measurements of each cistern, ventricle, parenchyma or groove near the cortex are used.<sup>19</sup>

Vasospasm development differs between patients undergoing microsurgical clipping and those undergoing endovascular treatment. Initially, both groups present perianeurysmatic spasm, with a distal progression only in microcoil-treated patients.<sup>20</sup>

Approximately 86% of the patients with delayed cerebral infarction had moderate or severe neuropsychological deficits. The presence of ischemia is associated with a higher propensity (6.38 times) for the development of cognitive sequelae, when compared with patients with and without late cerebral infarction.<sup>21</sup>

### Fisher Scale and Cognitive Alterations

The attempt to correlate the amount of blood identified in the cranial CT with the development of cognitive alterations in patients with HSA secondary to the rupture of cerebral aneurysms presents very conflicting data (→ **Table 2**).<sup>6</sup>

Kreiter et al<sup>22</sup> showed that the presence of blood in the interhemispheric fissure and in the sylvian fissure was related to a higher cognitive decline, although it did not demonstrate that higher scores were associated with cogni-

tive alterations, using the method pursued by Hijdra et al<sup>23</sup> that graduates the hematic densities in 10 cisterns/fissures and in the 4 ventricles.

Similarly, Caeiro et al<sup>24</sup> showed that the hematic density was not associated with neuropsychiatric disorders.

The FS was considered the most important factor related to language dysfunction in patients with anterior circulation aneurysm rupture.<sup>25</sup>

The neuropsychological evaluation (depression test) in patients with HSAa showed greater involvement in cases with anterior communicating artery aneurysm rupture, when compared with other locations, not being evidenced greater impairment of higher FS scores.<sup>26</sup> However, when evaluating the sample of this study, it was observed that 100% of the patients had FS scores 3 or 4.

Wong et al<sup>27</sup> demonstrated that 73% of the patients presented cognitive decline, when the Montreal Cognitive Assessment was used after 3 months of HSAa, with late cerebral infarction being the main risk factor. However, when analyzing our data, it is evident that 100% of the patients had FS scores 3 or 4, a result that precludes the association between the FS and cognitive deficits.

Sheldon et al<sup>28</sup> showed a significant difference in working memory among patients with HSAa and individuals considered normal. However, it was not possible to differentiate between the various degrees of the FS, probably due to the small sample of patients with HSAa (n=21). Comparing neuropsychological assessments in 3 groups of patients (HSAa, incidental aneurysms or perimesencephalic hemorrhage), it is evident that 78% of the patients with aneurysmatic HSA had scores 1 or 2 on the Fisher scale, with no difference in groups classified according to the FS.<sup>29</sup>

Literature reports indicate that 96% of patients with ischemia had a FS score of 3 or 4, with higher scores of this scale associated with 4.34 times greater propensity to the presence of neuropsychological alterations in univariate analysis, a fact not proven in multivariate analysis.<sup>21</sup>

When care tests were performed in patients with HSAa, it was observed that 58% of these presented alterations, although they had 4–5 scores in the Glasgow Outcome Scale (GOS). The FS evaluation, performed through the median, showed no

**Table 2** List of Articles Relating the Fisher's Scale (Fisher et al<sup>6</sup>) with Cognitive or Neuropsychological Assessments

Autors	Publication	Number of cases	Fisher 1 + 2	Fisher 3 + 4	Criteria	Relation
Fisher et al (1980) <sup>6</sup>	<i>Neurosurgery</i>	47	38.3%	61.7%	Vasospasm	+
Hütter et al (1998) <sup>25</sup>	<i>Neurosurgery</i>	51	22%	78%	Memory/attention	+
Yoo et al (2011) <sup>26</sup>	<i>Ann Rehabil Med</i>	20	–	100%	Depression	–
Wong et al (2012) <sup>27</sup>	<i>J Neurol Neurosurg Psychiatry</i>	90	–	100%	Cognition	–
Sheldon et al (2013) <sup>28</sup>	<i>J Neurol Sci</i>	21	Not related	Not related	Memory	–
Krajewski et al (2014) <sup>29</sup>	<i>Neurosurgical Review</i>	27	78%	22%	Cognition	–
Stienen et al (2014) <sup>21</sup>	<i>World Neurosurg</i>	92	28%	72%	Cognition	+
Wallmark et al (2015) <sup>30</sup>	<i>Stroke</i>	19	Not related	Not related	Attention	–
de Souza et al (2015) <sup>31</sup>	<i>World Neurosurg</i>	185	39.5%	60.5%	Language	+

statistical difference between patients with attention disorder and those considered normal, both with score 3.<sup>30</sup> Our research group correlated the various degrees of the FS with language alterations in individuals with HSAa secondary to rupture of the anterior circulation aneurysm in the period preceding the treatment, evidencing that the groups of patients with Fisher 3 and Fisher 4 presented worse scores in all assessments performed.<sup>31</sup>

## Conclusion

Because it is a pathology with high incidence in the population, the study of factors associated with a better outcome after rupture of a cerebral aneurysm is widely debated in the literature.

Several studies have sought to correlate the various degrees of the FS with cognitive alterations in individuals with HSAa. However, some of these studies did not undergo cognitive tests, or did not show differences between the FS grades by sampling difficulties.

The FS, even with its limitations and imperfections, seems to be a safe and easily reproducible way to predict neurological, cognitive or neuropsychological deficits, in view of its routine use in the analysis of patients with HSAa.

### Conflict of Interests

The authors have no conflict of interests to declare.

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