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The Relationship Between the Amount of Radiological Bleeding and The Development of Vasospasm in Aneurysm Hemorrhage: A 100-Case Retrospective Study

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Abstract

Objective: Intracranial aneurysms are pathological dilations of the intracranial arterial wall. The rupture of an aneurysm and the subsequent hemorrhage into the subarachnoid, intraventricular, or subdural spaces constitute a significant clinical condition associated with high morbidity and mortality. Aneurysmal subarachnoid hemorrhage (SAH) can lead to various severe complications, one of the most critical being ischemia due to cerebral vasospasm. In this study, we aim to analyze the relationship between the amount of hemorrhage and vasospasm.

Method: This study was conducted on patients admitted to the Neurosurgery Clinic of the Ministry of Health Ankara Training and Research Hospital with a diagnosis of spontaneous subarachnoid hemorrhage (SAH). The diagnosis of SAH was established based on computed tomography (CT) imaging and lumbar puncture (LP) findings. To diagnose aneurysms, all patients underwent four-vessel cerebral digital subtraction angiography (DSA). The CT images obtained at the time of admission were evaluated using the Fisher grading system. Additionally, angiographic vasospasm was assessed. For the statistical evaluation of the obtained results, the Z-test and chi-square (X^2) test were used to analyze proportions.

Results: The mean age of the patients was calculated as 49 years. The age distribution of the cases was as follows: 36% were in the 40-49 age group, 27% in the 50-59 age group, and 15% in the 60-69 age group. In terms of gender distribution, female predominance was observed, with 64% of the 100 cases being female and 36% male. According to the Fisher grading system, the highest incidence of subarachnoid hemorrhage on brain CT was observed in grade 3. The percentage of patients classified as Fisher grade 3 was 36%, followed by 33% in grade 4, 23% in grade 2, and 8% in grade 1. Angiographic vasospasm was defined as a contrast-narrowing phenomenon in the main cerebral arteries, which could be either focal or, in some cases, diffuse. Clinical vasospasm was detected in 23% of cases, whereas angiographic vasospasm was identified in 59% of cases. The

highest incidence of angiographic vasospasm was observed in Fisher grade 3, at a rate of 42.4%. This was followed by 32.2% in grade 4, 18.6% in grade 2, and 6.8% in grade 1. The high incidence in Fisher grade 3 was found to be statistically significant ($p<0.05$).

Conclusion: Our study highlights both the advantages and limitations of the Fisher grading system. A statistically significant relationship was found between Fisher grade 3 and cerebral vasospasm.

Keyword: Bipolar disorder, stigmatization, emotional expression, loneliness, stress, depression, and anxiety

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INTRODUCTION

Intracranial aneurysms are pathological dilations of the intracranial arterial wall. The rupture of an aneurysm and the subsequent hemorrhage into the subarachnoid, intraventricular, or subdural spaces constitute a serious clinical condition associated with high morbidity and mortality rates. Various studies have reported that the annual incidence of aneurysmal subarachnoid hemorrhage (SAH) is approximately 10-11 cases per 100,000 individuals. However, this incidence varies by region, with rates as low as 2 per 100,000 in China and as high as 16.8 to 18.33 per 100,000 in Japan and Finland (1).

Approximately 80% of patients with aneurysmal subarachnoid hemorrhage (SAH) experience a sudden and severe headache that is unresponsive to analgesics. In addition, symptoms suggestive of aneurysmal SAH include nausea, vomiting, altered consciousness, meningeal irritation signs, and focal neurological deficits (1).

Aneurysmal SAH can lead to serious complications, one of the most significant being cerebral ischemia, with cerebral vasospasm being one of its most critical clinical consequences (1,2). Vasospasm is defined as the focal or diffuse narrowing of arteries and can be detected using both radiological imaging techniques and clinical evaluation. Patients who develop vasospasm are at high risk for delayed ischemic neurological deficits due to reduced cerebral blood flow (3).

Various methods exist for classifying and predicting the development of vasospasm, one of the most commonly used being the Fisher Grading System. This system is considered one of the most effective tools for assessing the extent of subarachnoid hemorrhage on

computed tomography (CT) images. Additionally, it has a high predictive value for determining the timing and severity of cerebral vasospasm (4).

In this study, 100 patients who were admitted to the Neurosurgery Clinic of the Ministry of Health Ankara Training and Research Hospital with a diagnosis of spontaneous SAH between January 1993 and January 2005 were retrospectively analyzed both clinically and radiologically, and the findings were discussed in the context of the existing literature.

The aim of this study is to determine the incidence of vasospasm in aneurysmal subarachnoid hemorrhage patients using the Fisher Grading System and to evaluate the relationship between vasospasm and Fisher Grades. Furthermore, by retrospectively analyzing the clinical and radiological characteristics of the patients, this study seeks to examine the correlation between the severity of subarachnoid hemorrhage and the development of vasospasm in line with literature. In this regard, we aim for our study to contribute to the management of subarachnoid hemorrhage and to provide insight for future research.

METHODS

In this study, 100 patients who were admitted to the Neurosurgery Clinic of the Ministry of Health Ankara Training and Research Hospital with a diagnosis of spontaneous subarachnoid hemorrhage (SAH) between 1993 and 2005 and were found to have an intracranial aneurysm on angiography were retrospectively analyzed. Both surgically treated and untreated cases were included in the study. However, patients who died before undergoing angiography and patients with an aneurysm but without hemorrhage were excluded from the study.

Patient data were obtained by reviewing medical records. The diagnosis of SAH was established based on computed tomography (CT) imaging and lumbar puncture (LP) findings. To confirm aneurysm diagnosis, four-vessel cerebral digital subtraction angiography (DSA) was performed in all patients. In this study, CT images obtained at the time of admission were evaluated using the Fisher Grading System, and angiographic vasospasm analysis was conducted.

Statistical analysis

For the statistical analysis of the obtained data, the Z-test and chi-square (X^2) test were used.

RESULTS

The patients' ages ranged from 5 to 80 years, with a mean age of 49 years. The most common age distribution was observed in the 40-49 age group (36%), followed by the 50-59 age group (27%) and the 60-69 age group (15%) (Table 1).

There was a female predominance in the gender of the cases. Out of 100 cases, 64% were females and 36% were males. (Table 2)

Table.1 Distribution of Aneurysms by Age

Age	Number Of Cases	Rate (%)
0-10	2	2
11-20	2	2
21-30	3	3
31-40	10	10
41-50	36	36
51-60	27	27
61-70	15	15
71-80	5	5
TOTAL	100	100

Table.2 Distribution of Aneurysms According to Gender

	Female	Male
Number Of Cases	64	36
Rate(%)	64	36
Total	100	100

According to Fisher grading system, subarachnoid haemorrhage rate was higher at grade 3 in brain tomographs. The rate of grade 3 was 36%. This was followed by 33% grade 4, 23% grade 2 and 8% grade 1 (Table 3).

Table.3 Distribution of Cases According to Fisher Grading

Grade	Number of Cases	Rate (%)
Grade 1	8	8
Grade 2	23	23
Grade 3	36	36
Grade 4	33	33
TOTAL	100	100

Angiographic vasospasm was defined as a contrast narrowing of the main cerebral arteries, which was usually focal but could also be diffuse. We detected clinical vasospasm in 23% and angiographic vasospasm in 59% of the cases (Table 4).

Table.4 Clinical and Angiographic Vasospasm Case Distribution

Vasospasm	Number of Cases	Rate (%)
Clinical Vasospasm	23	23
Angiographic Vasospasm	59	59

DISCUSSION

Although subarachnoid hemorrhages (SAH) account for less than 5% of all stroke cases, they pose a high risk of morbidity and mortality. This condition can lead to long-term cognitive impairment, a significant decline in quality of life, and death. Since aneurysmal hemorrhages constitute 85% of non-traumatic subarachnoid hemorrhages, early detection and effective treatment of aneurysms are crucial in preventing such hemorrhagic strokes (5).

Literature reviews on aneurysmal subarachnoid hemorrhages indicate that these hemorrhages are most commonly observed in individuals aged 40 to 60 years (6). Bozkuş et al. reported that the incidence of aneurysmal SAH increases with age, being particularly more frequent in individuals in their 70s and 80s (7). In our study, the mean patient age was calculated as 49 years, and the obtained data were largely consistent with the age ranges reported in the literature. Furthermore, patients aged 70 years and older were also included in our study. Although our results do not completely overlap with those of Bozkuş et al., they exhibit similar trends.

In our study, female predominance was observed in the gender distribution of patients.

Literature reviews indicate that there are gender-related differences in the incidence of intracranial aneurysms. Turan et al., in a study on aneurysm formation and rupture based on gender, reported that the incidence of incidentally detected intracranial aneurysms was significantly higher in females compared to males (8). This finding has also been supported by a large-scale analysis involving more than 14,000 adults, which examined predictors of intracranial aneurysm presence (9).

The Fisher Grading System was developed in 1980 to predict the degree of cerebral vasospasm following subarachnoid hemorrhage. This hypothesis was validated in 1983 through a small sample group of 41 patients (10). However, a larger cohort study reported a relationship between subarachnoid hemorrhage and cerebral vasospasm but noted that this association was not statistically significant (11).

One of the major limitations of the Fisher Grading System is its inability to classify all types of intracranial hemorrhages occurring after aneurysm rupture. In particular, the classification of small focal subarachnoid hemorrhages, as well as intraparenchymal and intraventricular hemorrhages, remains unclear. Fisher Grade 4 includes only extensive subarachnoid hemorrhages and is used to describe cases where subarachnoid hemorrhage occurs without other types of bleeding. Additionally, it is not clearly defined how patients with both subarachnoid hemorrhage and subdural hematoma should be categorized within this system (12).

The Fisher Grading System was developed at a time when imaging technology had a resolution nearly ten times lower than today. With advancements in computed tomography (CT) technology, the quantification of subarachnoid blood volume can now be performed with significantly greater precision. Notably, even when the subarachnoid hemorrhage is less than 1 mm thick, modern CT scans can detect this minimal amount of blood in almost every section. To overcome the limitations of the Fisher classification system, ongoing research continues to focus on new measurement methods and classification systems, including three-dimensional imaging-assisted programs and advanced computational techniques (13).

The incidence of vasospasm in subarachnoid hemorrhage (SAH) patients varies between 9% and 93%, and it has been reported to account for approximately half of the mortality in the period following the initial hemorrhage and aneurysm treatment (14, 15). In approximately 67% of patients with aneurysmal SAH, angiographically detectable vasospasm has been observed, with severity exceeding mild levels (16).

Vasospasm is considered one of the most critical complications of subarachnoid hemorrhage, making early recognition and management essential (17,18). Although the

underlying mechanisms of vasospasm are not yet fully understood, literature reports indicate that the extent of clot dispersion within the subarachnoid space is associated with this risk. Additionally, young age, smoking, substance use, and hypertension have been identified as risk factors for vasospasm. Moreover, the amount of hemorrhage classified by the Fisher Grading System has also been shown to be a significant risk factor. The hemorrhagic burden following subarachnoid hemorrhage may serve as an important predictor of delayed cerebral ischemia, poor functional outcomes, and increased mortality and morbidity (14, 19).

In the literature, higher Fisher, WFNS, and Hunt & Hess (HH) scores have been reported to be associated with cerebral vasospasm. In a study conducted by Varol et al., a significant correlation between cerebral vasospasm and these three classification systems was found, with Fisher (p=0.005), WFNS (p=0.002), and HH (p=0.02) scores demonstrating statistical significance (17,20,21).

Our study evaluates the prognostic significance of the Fisher Grading System in aneurysmal subarachnoid hemorrhage and its relationship with vasospasm. Our findings are largely consistent with previously reported age and gender distributions in the literature. Additionally, our results indicate that Fisher Grade 3 is associated with the highest incidence of subarachnoid hemorrhage and a significantly increased rate of angiographic vasospasm. However, although a positive correlation was identified between Fisher grade and vasospasm severity in our study, this relationship was not found to be statistically significant.

In our study, patients were categorized according to the Fisher Grading System. Patients with intracranial hemorrhage extending into the subdural space were classified as Fisher Grade 4, regardless of the amount of subarachnoid hemorrhage. According to CT findings, the highest incidence of subarachnoid hemorrhage was observed in Fisher Grade 3 (36%), followed by Fisher Grade 4 (33%), Fisher Grade 2 (23%), and Fisher Grade 1 (8%). Clinical vasospasm was detected in 23% of cases, whereas angiographic vasospasm was identified in 59%. The highest incidence of angiographic vasospasm was found in Fisher Grade 3 (42.4%), followed by Fisher Grade 4 (32.2%), Fisher Grade 2 (18.6%), and Fisher Grade 1 (6.8%). The increased incidence in Fisher Grade 3 was found to be statistically significant.

The amount and distribution of subarachnoid hemorrhage are among the key factors that can influence the clinical course and prognosis of patients. Although the Fisher Grading System remains one of the most frequently used classification methods, advancements in imaging technology have highlighted the ongoing need for more precise and comprehensive classification systems.

LIMITATIONS

This study has certain limitations. First, due to its retrospective design, there is a possibility of missing or incomplete patient data. Second, the relatively small sample size may limit the statistical power of the findings. Finally, all imaging evaluations were conducted at a single center, which may affect the generalizability of the results when compared to studies conducted in multiple centers.

Future prospective studies with larger patient populations are needed to provide a more comprehensive evaluation of the prognostic value of the Fisher Grading System.

CONCLUSION

In conclusion, aneurysmal hemorrhage should always be considered in patients in their fifties presenting with spontaneous subarachnoid hemorrhage. Given that this condition can lead to serious complications such as vasospasm and stroke, rapid clinical and radiological evaluation is essential, and the most appropriate treatment should be planned in a timely manner.

Our study highlights both the advantages and limitations of the Fisher Grading System. Our findings indicate that Fisher Grade 3 is significantly associated with cerebral vasospasm.

The diagnosis of subarachnoid hemorrhage can be established quickly and effectively using computed tomography (CT). In cases where CT findings are inconclusive, lumbar puncture (LP) may serve as a diagnostic alternative.

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Ethics Committee Approval: Since the study was a retrospective thesis study conducted in 2005, Ethics Committee approval was not obtained.

We state that the parents have given their written informed consent to be involved in the study, in accordance with the Declaration of Helsinki.

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