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# Results of assessing cerebral vasospasm following subarachnoid hemorrhage using transcranial doppler ultrasound

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## SUMMARY

**Objective:** Review the results of assessing cerebral vasospasm after subarachnoid hemorrhage using transcranial doppler ultrasound.

**Subjects and methods:** A retrospective, cross-sectional descriptive study was performed on 39 patients with subarachnoid hemorrhage treated at the Neurology Center, Bach Mai Hospital from January 2020 to September 2023.

**Results:** The mean age of the study group was 55.12 ± 14.33. The age group distribution with the highest incidence is 41-50 years old with a rate of 35.9%. The male/female ratio is 20/19. The most common symptoms were headache (97.4%), nausea and vomiting (92.3%), The least common symptoms were convulsions and hemiplegia in 5.1% of subjects. The most common clinical severity assessed by the Hunt and Hess scale is level 2 (59%), followed by level 3 (23.1%), level 4 (10.2%), and level 1 (5.1%). Evaluation of Fisher scale found that the most common fisher level is level 4 with a rate of 33.6%, followed by level 3 (28.2%), level 1 (25.6%), the least common is grade 2 with 2.6%. The results of the second transcranial Doppler ultrasound performed on the sixth to eighth day of the disease is the time with the highest rate of vasospasm, showing the most vasospasm cerebral artery is the middle cerebral artery: right middle cerebral artery. 35.9%, left middle cerebral artery 12.8%. Next is anterior cerebral artery spasm: right anterior cerebral artery 23.1%, left anterior cerebral artery 2.6%. Right posterior cerebral artery 10.3%, left posterior cerebral artery 5.1%. Compared to the gold standard for diagnosing vasospasm, which is 128-slices MSCT, transcranial Doppler ultrasound has a sensitivity of 0.91, a specificity of 0.88, a positive predictive value of 0.91, and a negative predictive value of 0.88. The appropriateness of transcranial

Doppler ultrasound and 128-slices computed tomography scan in diagnosing cerebral vasospasm after subarachnoid hemorrhage is very high, Kappa coefficient = 0.791, statistically significant with $p < 0.05$.

Conclusion: Clinical symptoms of the disease are very diverse and non-specific, the most common symptom being headache is 97.4%. The most common Hunt and Hess scale to assess clinical severity is 2, however the most common Fisher scale is 4. Middle cerebral artery thrombosis has the highest rate of spasm, followed by the anterior cerebral artery. Compared to the gold standard for diagnosing vasospasm, which is 128-slices MSCT, transcranial Doppler ultrasound has a sensitivity of 0.91, a specificity of 0.88, a positive predictive value of 0.91, and a negative predictive value of 0.88

**Keywords:** Subarachnoid hemorrhage, clinical, subclinical, multislice computed tomography, transcranial doppler ultrasound

## I. INTRODUCTION

Subarachnoid hemorrhage is Intracranial bleeding between the arachnoid membrane and the pia mater. Subarachnoid hemorrhage is a dangerous clinical diagnosis with a high risk of death and disability. However, the clinical symptoms of subarachnoid hemorrhage are very diverse and atypical, and can be overlooked or misdiagnosed with common primary headaches or meningitis. The most common cause of non-traumatic subarachnoid hemorrhage is a ruptured aneurysm, accounting for 80%.[1] The frequency of misdiagnosis of subarachnoid hemorrhage in different studies can range from 12% to 51%.[2] The prognosis of patients with subarachnoid hemorrhage depends largely on the ability to early diagnosis and intervention. Late diagnosis or missed diagnosis is the leading risk factor of increased mortality, disability, treatment costs, and disease burden in countries. Late cerebral ischemia is one of the most worrisome neurological complications after subarachnoid hemorrhage. The most common cause of delayed cerebral ischemia after subarachnoid hemorrhage is thought to be vasospasm.[3]

Therefore, we conducted this study with the objective: "Review of the results of cerebral vasospasm after subarachnoid hemorrhage by transcranial doppler ultrasound"

## II. SUBJECTS AND METHODS

### 2.1. Study Subjects

The study subjects included 39 patients diagnosed of subarachnoid hemorrhage treated at the Neurology Center, Bach Mai Hospital from June 2020 to September 2023.

### 2.2. Research methods

Descriptive, retrospective study.

## III. RESULTS

### 3.1. Characteristics of subjects

*Table 1. Characteristics of subjects*

| Age-Sex | Male | Female | Total |
|---|---|---|---|
| | n=20 (51.2%) | n=19 (48.8%) | n=39 (100%) |
| Mean age | 46. 0 ± 11. 8 | 58. 2 ± 14. 2 | 55. 1 ± 14. 3 |

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| Age-Sex | | Male | Female | Total |
|---|---|---|---|---|
| | | n=20 (51.2%) | n=19 (48.8%) | n=39 (100%) |
| (Range) | | (37 – 63) | (36-81) | (36-81) |
| Age group distribution | ≤ 40 | 3 (7.7) | 3 (7.7) | 6 (15.4) |
| | 41-50 | 9 (23.1) | 5 (12.8) | 14 (35.9) |
| | 51-60 | 4 (10.3) | 5 (12.8) | 9 (23.1) |
| | ≥ 60 | 4 (10.3) | 6 (15.3) | 10 (25.6) |

***Observation:*** The study was conducted on 39 patients. The mean age was 55.1 ± 14.3, the youngest was 36 and the oldest was 81. The mean age of onset in men was 46.0 ± 11.8, lower than the mean age of onset in women 55.1 ± 14.3. The age group with the highest incidence rate was 41-50 years old with a rate of 35.9%. The male/female ratio was 20/19.

### 3.2. Clinical features and results of evaluation of cerebral vasospasm after subarachnoid hemorrhage by transcranial doppler ultrasound

#### *3.2.1. Symptoms of subarachnoid hemorrhage*

***Table 2****. Symptoms of subarachnoid hemorrhage*

| Symptom | Subjects (n=39) | Percentage (%) |
|---|---|---|
| Headache | 38 | 97.4 |
| Nausea and vomiting | 36 | 92.3 |
| Stiff neck | 33 | 84.6 |
| Kernig sign | 30 | 76.9 |
| Unconsciousness | 13 | 33.3 |
| Convulsion | 2 | 5.1 |
| Hemiplegia | 2 | 5.1 |

***Observation:*** Among the symptoms of the acute phase, headache was the most common symptom, accounting for 97.4%. Nausea and vomiting were less common, accounting for 92.3%. The least common symptoms were convulsions and hemiplegia, occurring in 5.1% of the study subjects.

### 3.2.2. Hunt and Hess scale

***Table 3**. Hunt and Hess scale*

| Hunt-Hess sclae | Subjects (n=39) | Percentage (%) |
|---|---|---|
| Grade 1 | 2 | 5.1 |
| Grade 2 | 23 | 59.0 |
| Grade 3 | 9 | 23.1 |
| Grade 4 | 4 | 10.2 |
| Grade 5 | 1 | 2.6 |

***Observation:*** Hunt-Hess grade 2 was the most common with a rate of 59%, followed by grade 3 (23.1%), grade 4 (10.2%), and grade 1 (5.1%).

### 3.2.3. Fisher scale

***Table 4**. Fisher scale*

| Fisher scale | No vasospasm | | Vasospasm | | Total % |
|---|---|---|---|---|---|
| | Number of cases | Percentage % | Number of cases | Percentage % | |
| Grade I | 5 | 12.8 | 5 | 12.8 | 25.6 |
| Grade II | 1 | 2.6 | 0 | 0 | 2.6 |
| Grade III | 6 | 15.4 | 5 | 12.8 | 28.2 |
| Grade IV | 5 | 12.8 | 12 | 30.8 | 43.6 |
| Total | 17 | 43.6 | 22 | 56.4 | 100 |

***Observation:*** On brain CT scan, the most common Fisher grade was grade 4 with a rate of 33.6%, followed by grade 3 (28.2%), grade 1 (25.6%), and the least common was grade 2 with 2.6%.

### 3.2.4. Results of evaluation of cerebral vasospasm after subarachnoid hemorrhage by transcranial doppler ultrasound

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***Table 5**. Rate of vasospasm at second ultrasound*

| Artery | No vasospasm | | Vasospasm | |
|---|---|---|---|---|
| | Cases (n=39) | Percentage % | Cases (n=39) | Percentage % |
| Right MCA | 25 | 64.1 | 14 | 35.9 |
| Left MCA | 34 | 87.2 | 5 | 12.8 |
| Right ACA | 30 | 76.9 | 9 | 23.1 |
| Left ACA | 38 | 97.4 | 1 | 2.6 |
| Right PCA | 35 | 89.7 | 4 | 10.3 |
| Left PCA | 37 | 94.9 | 2 | 5.1 |

**Observation:** The second transcranial Doppler ultrasound results were performed on the sixth to eighth day of the disease, which was the time with the highest rate of vasospasm, showing the most vasospasm in the middle cerebral artery: right middle cerebral artery 35.9%, left middle cerebral artery 12.8%. Next was vasospasm in the anterior cerebral artery: right anterior cerebral artery 23.1%, left anterior cerebral artery 2.6%. Right posterior cerebral artery 10.3%, left posterior cerebral artery 5.1%.

***Table 6**. Comparison of the diagnostic ability of cerebral vasospasm between TCD and 128-slice MSCT*

| TCD | 128-slice MSCT | | | Kappa coefficient | p |
|---|---|---|---|---|---|
| | Vasospasm | No Vasospasm | Total | | |
| Vasospasm | 20 | 2 | 22 | 0. 791 | <0. 05 |
| No Vasospasm | 2 | 15 | 17 | | |
| Total | 22 | 17 | 39 | | |

***Observation:*** Compared with the gold standard for diagnosing vasospasm, 128-slice CT, transcranial Doppler ultrasound had a sensitivity of 0.91, specificity of 0.88, positive predictive value of 0.91, and negative predictive value of 0.88. The agreement between transcranial Doppler ultrasound and 128-slice CT in diagnosing cerebral vasospasm after subarachnoid hemorrhage was very high, with a Kappa coefficient of 0.791, statistically significant with $p < 0.05$.

## IV. DISCUSSION

The study was conducted on 39 patients diagnosed with subarachnoid hemorrhage treated at the Neurology Center, Bach Mai Hospital from January 2020 to September 2023. The average age was 55.1 ± 14.3, the youngest age was 36 and the oldest was 81. The average age of men was 46.0 ± 11.8, lower than the average age of women 55.1 ± 14.3. The age group with the highest incidence rate was 41-50 years old with a rate of 35.9%, the male/female ratio was 20/19. This result is also consistent with the study of Le Van Thinh et al., and Vo Hong Khoi et al. [4,5]

The clinical symptoms of the acute phase of patients with subarachnoid hemorrhage are relatively diverse, with headache being the most common symptom accounting for 97.4%. Nausea and vomiting were less common with a rate of 92.3%. The least common symptoms were convulsions and hemiplegia, occurring in 5.1% of the study subjects. In the study of Vo Hong Khoi in 2012 on 316 patients, the rate of headache was 97.5%, stiff neck was 96.8%, Kernig's sign was 94.9%, fever was 92.4%, vomiting and nausea were 25.3%, consciousness disorder was 13.6%, hemiplegia was 8.5%, in addition there were some other symptoms that we did not observe in this study such as e, sphincter disorders, and central VII paralysis.[4] Hunt and Hess grade 2 were the most common with a rate of 59%, followed by grade 3 (23.1%), grade 4 (10.2%), and grade 1 (5.1%). Paraclinical assessment using the Fisher scale found that the most common Fisher level was level 4 with a rate of 33.6%, followed by level 3 (28.2%), level 1 (25.6%), and the least common was level 2 with 2.6%.[4,6] The different results can be explained by the fact that the study sample size was not large enough, through which it can be seen that some clinical symptoms such as headache, stiff neck, and Kernig's sign are very valuable in diagnosing subarachnoid hemorrhage.

The second transcranial Doppler ultrasound results were conducted on the sixth to eighth day of the disease, which was the time with the highest rate of vasospasm, showing that the middle cerebral artery had the most vasospasm: right middle cerebral artery 35.9%, left middle cerebral artery 12.8%. Next was anterior cerebral artery spasm: right anterior cerebral artery 23.1%, left anterior cerebral artery 2.6%. Right posterior cerebral artery 10.3%, left posterior cerebral artery 5.1%. Compared with the gold standard for diagnosing vasospasm, 128-slice MSCT, transcranial Doppler ultrasound has a sensitivity of 0.91, specificity of 0.88, positive predictive value of 0.91, negative predictive value of 0.88. The agreement between transcranial Doppler ultrasound and 128-slice CT in diagnosing cerebral vasospasm after subarachnoid hemorrhage is very high, with a Kappa coefficient of 0.791, statistically significant with $p < 0.05$. This result is similar to a number of domestic and foreign studies.[4,7]

## V. CONCLUSION AND RECOMMENDATIONS

The clinical symptoms of the acute phase of subarachnoid hemorrhage are relatively diverse, headache is the most common symptom accounting for 97.4%. Nausea and vomiting are less common with a rate of 92.3%. The least common symptoms are convulsions and hemiplegia occurring in 5.1% of the study subjects. Symptoms of headache, vomiting, stiff neck and Kernig's sign are very valuable in diagnosing subarachnoid hemorrhage. The Hunt and Hess scale assesses the most common clinical severity as 2, however it is not similar to the paraclinical severity assessed by the Fisher

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scale, which is most commonly 4, thereby showing that the degree of bleeding is not similar to the severity of clinical manifestations. The middle cerebral artery has the highest rate of vasospasm: right middle cerebral artery 35.9%, left middle cerebral artery 12.8%. Next is anterior cerebral artery spasm: right anterior cerebral artery 23.1%, left anterior cerebral artery 2.6%. Right posterior cerebral artery 10.3%, left posterior cerebral artery 5.1%. Compared with the gold standard for diagnosing vasospasm, 128-slice MSCT, transcranial Doppler ultrasound had a sensitivity of 0.91, specificity of 0.88, positive predictive value of 0.91, negative predictive value of 0.88, showing that the value of transcranial Doppler ultrasound in diagnosing vasospasm is very high.

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