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

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

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 $p < 0.05$.