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Patients' Outcomes and Subarachnoid Hemorrhage Grading Scores Among Those Diagnosed with Aneurysmal Subarachnoid Hemorrhage in a Tertiary Government Hospital

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Objective: This study aims to determine the clinical outcome of patients diagnosed with aneurysmal subarachnoid hemorrhage and their association with grading scores.

Methods: The authors conducted a single-center cross- sectional study involving patients diagnosed with aneurysmal subarachnoid hemorrhage admitted at Vicente Sotto Memorial Medical Center, Cebu City, Philippines from January 2015 to December 2020.

Results: Out of 240 patients diagnosed with ruptured aneurysms, 215 underwent definitive treatment. The average age was 56 years old, predominantly female with a ratio of 2:1. Most patients were classified with admitting Hunt and Hess grading scale of 2-3 and Fisher grading scale of 3. Females had increased incidence of multiple aneurysms (ratio 3:1) compared to male sex. Among patients, 197 underwent clipping while 18 underwent coiling. Clinical Outcome revealed that 84% had good outcome while 16% had poor outcome. The association between Hunt and Hess grading scale and patient outcome was statistically significant ($p < 0.001$) as well as for Fisher grading scale and patient outcome ($p < 0.001$). Fisher grading scale and incidence of clinical vasospasm were also significant ($p = 0.004$).

Conclusion: Higher scores for Hunt and Hess grading scale and Fisher grading scale were associated with poor outcome. Higher Fisher grading scale was associated with the occurrence of clinical vasospasm among patients with ruptured aneurysm. Female sex also had higher aneurysm incidence with complex and more multiple aneurysms as compared to male sex.

Key words: aneurysm ruptured, subarachnoid hemorrhage, Hunt and Hess Grading Scale, Fisher Grading Scale

Aneurysmal subarachnoid hemorrhage (aSAH) is a common neurological condition that accounts for 80% of nontraumatic SAH.[1] It is still associated with significant morbidity and mortality.[2] Despite recent advances in diagnostic imaging, endovascular and microsurgicaltechniques, as well as perioperative intensive care unit management survival rate has increased by just 17%.[3-6] The clinical outcome of patients who survive aSAH ranges between complete independence and permanent disability. The clinical status of the patient at admission is probably the single most important predictor of outcome. Hunt and Hess grading system which is based on neurologic deficit and level of consciousness is used upon admission in this institution and is intended to be a gauge of surgical risk. The subgroups of patients who present with a depressed level of consciousness generally do poorly. Surgical treatment of patients with poor grade (grades 4 and 5) is delayed until they show clinical improvement (grades 1–3). Patients with good grade (1-3) were taken to surgery as soon as possible. Fisher grading which corresponds to the presence and thickness of blood in the brain via computed tomography (CT) scan was determined to assess the risk of clinical vasospasm.

Both open surgery and endovascular techniques are valid options for treatment. Endovascular coiling favored in patients suitable for both treatments as it is more likely to result in independent survival at 1 year compared to neurosurgical clipping.[7] However in patients less than 40 years old, the advantage of coil embolization over clip ligation is not as clear;[8] open aneurysm clipping may have the advantage of a better life expectancy for these patients.[9]

Early detection and treatment of aSAH has contributed to the increased chance of survival and better prognosis of patients. In the local setting, the available facilities as well as the presence of trained vascular neurosurgeons allows surgeons to handle these complex cases with

bestoutcome.

The study aimed to determine patient's outcome and their association with subarachnoid hemorrhage grading scores. Specifically, it aimed to characterize the demographic profile of patients, treatment options, distribution of aneurysms, length of hospitalization and complications.

Methods

Study Design

This was a single-center retrospective cohort study on patients with aneurysmal subarachnoid hemorrhage.

Study Setting and Population

The study was conducted at Vicente Sotto Memorial Medical Center (VSMMC), a tertiary government hospital located in Cebu City, Philippines. All patients diagnosed with a ruptured cerebral aneurysm who underwent cerebral catheter angiogram or CT angiography from January 2015 to December 2020 were included.

Data Collection Procedure

All data were retrieved from the medical records, Cerebral Catheter Laboratory and Department of Neurosurgery data bank from January 2015 to December 2020. Specific details in the chart were noted, such as: age, sex, postictal day upon admission, GCS score, Hunt and Hess grading, Fisher grading on CT scan, admission to angiography time, admission to surgery time, size of aneurysm, location of aneurysm, open surgery vs endovascular surgery, complications, length of hospital stay, and outcome of patients.

Clinical vasospasm is defined in this study as new focal neurologic deterioration of the level of consciousness that may be due to vasospasm-induced ischemia after other etiologies have been ruled out. Radiologic vasospasm, on the other hand, is narrowing of the cerebral arteries in cerebral angiography with or without clinical symptoms.

Data Analysis

The following statistical tests were employed in this study:

Frequency and simple percentage were used to determine the distribution of patients in terms of different categorical variables, such as sex, Hunt and Hess classification, Fisher Grade classification, treatment procedure, classification of aneurysm, CSF drainage, and outcome of patients.

Descriptive statistics such as Mean, Standard Deviation (SD), Median, Interquartile Range (Q1-Q3),, and the Minimum and Maximum Values were reported to describe the distribution of patients in terms of different numerical variables: patients' age, average ictus in days, turnaround time from admission to angiography and from angiography to surgery, and overall length of hospitalization.

Cramer's V^2 was used to determine if there was association between categorical variables such as Fisher Grade and incidence of clinical vasospasm due to violations in the assumptions for Chi-square Test for Independence. A value of 0 indicates that there is no association; a value of 1 indicates that there is a perfect association.

Spearman's Rank Correlation was used to determine if there was a relationship between ordinal variables such as: Hunt and Hess Classification Grade and Glasgow Outcome Scale (GOS) and also the latter and Fisher Grade.

Mann-Whitney U Test was used to determine if there is significant difference between the two groups: those with and without clinical vasospasm, in terms of their median Fisher Grade.

Glasgow Outcome Scale (GOS) was used to determine the clinical outcome of patients who underwent definitive treatment: good outcome with GOS 4 and 5 while poor outcome with GOS 1-3

All hypotheses on associations and comparisons were tested at 0.05 level of significance. Data were entered with Microsoft Excel Spreadsheet. Minitab version 21.1 for Mac Mojave OS via Minitab License Portal was used in the statistical computations and analysis of data.

Data Privacy and Ethical Considerations

The study was approved by the VSMMC Research Ethics Committee. The privacy and confidentiality were maintained throughout the research process. The researchers maintained no communication with the study participants.

Results

The clinical characteristics of patients with ruptured aneurysm are shown in Table 1. The total number of diagnosed patients with ruptured aneurysms was 240, 163 were female while 77 were male, with a ratio of 2:1. Twenty-five patients declined the definitive management, thus only 215 patients underwent surgery. The average age of patients admitted for ruptured aneurysm was 56±10.793; the youngest and oldest were 19 and 81 years old, respectively. Upon admission, majority of patientswere classified as Hunt and Hess Grade 2 (n=76) and Grade 3 (n=74). Fisher Grade 3 was the most common at n=77 during admission.

Table 2 shows turnaround time from admission to angiography was 2 days while the turnaround time from angiography to surgery was 1 day. Of the 215 patients who had definitive treatment, 197 underwent clipping while 18 underwent coiling. The most common location of aneurysm was in the anterior communicating artery, which was found in 80 patients, followed by the posterior communicating artery in 67, and the middle cerebral artery in 32 patients. Other locations were also noted as depicted on Table 2. Among the subjects, 36 patients had multiple aneurysms; of these, 27 were female and 9 were male. Before the planned clipping, 10 patients underwent tube ventriculostomy due to hydrocephalus. Postoperatively, 16 patients were noted to have deterioration due to vasospasm.

Table 3 shows complications in this cohort of patients. One hundred and fifty patients were discharged without complications. In the 65 patients who experienced complications, clinical vasospasm was the most common, followed by post hemorrhagic hydrocephalus and pneumonia. The average length of hospital stay was 19 dayswith a minimum hospital stay of 6 days and maximum of 91 days.

Table 4 shows 84% of patients (GOS 4 and 5) had

Table 1. Clinical characteristics of patients with ruptured aneurysm who underwent treatment procedure, from 2015-2020, VSMMC

Patients'		**N=215**	
Clinical Characteristics		**Average (±SD)**	**Min-Max**
Age *in years, Mean (SD)*		55.58 (10.93)	19-81
Glasgow Coma Scale Score *upon admission, Mean (SD)*		13.99 (1.83)	7-15
Hunt and Hess Classification Grade *upon admission, Median (IQR)*		3.00 (1.00)	
Fisher Grade *upon admission, Median (IQR)*		2.50 (1.00)	
		no	**%**
Sex			
	Female	143	66.51
	Male	72	33.49
Hunt and Hess Classification			
	Grade 1	15	6.98
	Grade 2	76	35.35
	Grade 3	74	34.42
	Grade 4	47	21.86
	Grade 5	3	1.39
Fisher Grade			
	Grade 1	34	15.81
	Grade 2	71	33.02
	Grade 3	77	35.81
	Grade 4	33	15.35

Table 2. Procedure profile of treated patients with rupture cerebral aneurysms, VSMMC, 2015-2020

Procedure	**N=215**	
Variables	**Mean (SD)**	**Min-Max**
Admission to angiography *in days*	1.73 (1.91)	0-17
Angiography to surgery *in days*	1.21 (1.80)	0.08-14
	No	**%**
Treatment procedure		
Clipping (with or without reconstruction)	197	91.63
Coiling	18	8.37
Location of aneurysm		
anterior communicating artery	80	37.21
post communicating artery	67	31.16
middle cerebral artery	32	14.88
anterior cerebral artery	11	5.12
internal carotid artery	8	3.72
anterior choroidal	5	2.32
post cerebral artery	3	1.40
superior hypophyseal artery	3	1.40
Inferior hypophyseal artery	2	0.93
ophthalmic artery	2	0.93
pericallosal artery	2	0.93
External ventricular drainage (EVD) prior to clipping	10	4.65
Incidence of clinical vasospasm	16	7.44
Incidence of radiographic vasospasm	24	11.16

Table 3. Complications among postoperative patients, VSMMC, 2015-2020

Complications	**N=215**	
	No.	**%**
Without complications	**150**	**69.77**
With complications	**65**	**30.23**
Clinical Vasospasm	16	24.62
Hydrocephalus	10	15.38
Pneumonia	6	9.23
VAP	5	7.69
HAP	4	6.15
Herniation	4	6.15
HCVD	3	4.62
Sepsis	3	4.62
SSI	3	4.62
Hematoma	2	3.08
MI	2	3.08
AKI	1	1.54
Anemia	1	1.54
Bacteremia	1	1.54
Decubitus ulcer	1	1.54
Edema	1	1.54
Infarct	1	1.54
Re-rupture	1	1.54

goodoutcome while 16% (GOS 1-3) had poor outcome. Majority of the patients scored GOS 5.

Table 5 presents the results when testing the relationship between patient outcomes and subarachnoid hemorrhage grading scores. The association between Hunt and Hess Classification Grade and patient outcome is statistically significant (p-value <0.001). There is enough evidence to conclude Hunt and Hess Classification Grade is associated with outcomes of patients with ruptured aneurysm. Based on the computed value (Spearman's Rho) of -0.424, a negative monotonic correlation wasdetected between Hunt and Hess Classification Grade and patient out-come. This means that higher Hunt and Hess Classification scores are associated with poor patient outcome. The same is true for Fisher Grade and patient outcome with p-value <0.001. Higher Fisher Grade scores are associated with poorer patient outcome.

As shown in Table 5, patients who developed clinical vasospasm had a significantly higher median Fisher Grade (4.0) compared to those who did not (2.0). This difference was statistically significant (p = 0.004). In addition, there was an association, albeit weak, between the two variables.

Discussion

Clinical Characteristics

Table 4. Glasgow Outcome Scale (GOS) of postoperative patients, VSMMC, 2015-2020.

Patients' Outcome	Glasgow Outcome Scale	N=215	
		Average	Min-Max
GOS, median (Interquartile Rate)		5(1)	1-5
		No	**%**
Good	5	158	73.49
	4	23	10.70
Poor	3	15	6.98
	2	0	0.00
	1	19	8.83

Table 5. Association between patient outcomes (GOS) and subarachnoid hemorrhage grading scores of patients with ruptured cerebral aneurysms, VSMMC, 2015-2020.

Variables for Association	Computed Values	p-Value	Interpretation
Hunt and Hess Classification Grade and Patient Outcome (GOS)	-0.424 [a]	<0.001	**significant association**
Fisher Grade and Patient Outcome (GOS)	-0.393 [a]	<0.001	**significant association**
Fisher Grade and Incidence of clinical vasospasm	no η_1=2.0; with η_2=4.0 [b]	**0.004**	**Significant difference**
	0.1080 [c]	-	**Weak association**

a Spearman's rho; value computed using Spearman's Rank Correlation; *significant at <0.05*

b Median values; Comparison done with Mann-Whitney U Test; significant at <0.05

c value computed using Cramer's V^2 due to violation/s in Chi-square test assumptions

The clinical status of patients at admission was the most important predictor of outcomes. The patients' clinical characteristics in this study showed an average age of 56 years and majority were classified as Hunt and Hess grading scale 2 or 3, Fisher Grading scale 2 or 3 on admission. Advanced age is a recognized prognostic indicator of poor outcome after SAH. Likewise, the incidence of SAH increases with advancing age.[10] Furthermore, during the treatment period, the incidence of severe complications like clinical vasospasm and pneumonia were also increased in advancing age.

In this study, the most common location of the aneurysm was in the anterior communicating artery. In literatures, they account as high as 45% of ruptured aneurysm[11] and necessitate aggressive management. Multiple intracranial aneurysms are also discovered in 15% to 35% of patients with aneurysm who present with SAH[12] and population-based studies have indicated that increased age and female sex are significantly associated with SAH.[12] The present study showed that female sex was prone to have cerebral aneurysm twice as much as male and were likely to have multiple aneurysms.

The patients who had a poor clinical grade, those who came in stupor or coma, with moderate to severe hemiparesis or with posturing (Hunt and Hess grades 4 and 5) generally had a poor prognosis. They usually compose about 20%–30% of those admitted to the hospital with aneurysmal SAH.[13] For those who already had a CT scan, the likelihood of clinical vasospasm increases with the thickness of blood. These grading scales have provided neurosurgeons and neuro-interventionalists over the years with simple and reproducible means of predicting outcomes independent of treatment.[14] These findings were also significant in this present study.

Published studies emphasized delaying surgery to patients with poor grade aneurysms (Grade 4-5) until they showed clinical improvement (grade 1-3).[15]Comparatively, most of the patients in this study had good grade aneurysms, thus immediate surgeries were performed. Majority underwent clipping while only a few underwent coiling. This is due to the financial limitation
of patients in acquiring materials for coiling. Many large-scale studies have compared the therapeutic efficacy of coiling and clipping, including the International Subarachnoid Aneurysm Trial (ISAT).[7] The ISAT studyshowed that endovascular coiling is more likely to result in independent survival at 1 year than neurological clipping. Similarly, with the ISAT patient selections, the present study included almost low grade (grades II or III) aneurysms which accounted for almost 70% of the subjects, and the average age was 56 years old. Unfortunately, the demographic profiles of these patients belong to low-income family, so most of these patients underwent open surgery which was comparable in terms of outcome to coiling.

VSMMC is the brain center of the Visayas region and most of the patients with aSAH are referred to this institution. Charity patients are subsidized by the Philippine government. As endovascular surgeries are expensive in the country, charity aSAH patients were managed primarily with craniotomy and clipping.

Before the planned clipping, 10 patients underwent tube ventriculostomy due to hydrocephalus and were classified as poor grade since most of them had an intraventricular bleed. A temporizing procedure such as tube ventriculostomy also posed a risk for infection since the materials used were modified external ventriculostomy drain. Some patients developed hydrocephalus post clipping or coiling but these were not elaborated in the study. Clinical vasospasm was the most common postoperative complication in this study; 16 of them had deterioration due to vasospasm. Clinical vasospasm is usually observed 3-14 days post ictus and usually treated supportively.[16]Nimodipine is also given to patients up to 21 days postictus to decrease the incidence of vasospasm, but the mechanism is still unknown.[17]

This study also showed that at this institution turnover time for admission to angiography was 2 days and 1 day for angiography to surgery. This demonstrates a short interval between diagnosis and definitive treatment can be achieved. Extended turnover times might be caused by conflicts in angiography schedules, inavailability of materials especially clips, a lack of the appropriate facilities, or a lack of experienced, skilled neurosurgeons. The benefits of early surgery and late surgery for SAH have also compared in many studies.[18,19,20] Earlier
treatment of ruptured aneurysms lowers the incidence of rebleeding and delayed cerebral ischemia. Consequently, proper interpretation of angiography results and earlysurgery of SAH will result in better outcomes.

Patient Outcomes and SAH Grading Scores

Hunt and Hess (HH) Grading Scale and World Federation of Neurological Society (WFNS) scales are the most used clinical scores in the regular treatment and assessment of aSAH patients.[21] In this study, the Hunt and Hess grading scale was utilized since this is the format used in the emergency department to which the residents are familiar with. Availability of CT scan machine in the hospital is vital in addressing the urgency of management of patients with aSAH. As the most widely accepted radiological scores, the Fisher grading scale quantifies the amount of bleeding to predict the incidence of vasospasm and delayed cerebral ischemia (DCI).[22] Based on the pattern of SAH in CT scan, the possible location of ruptured aneurysm can be deduced.

In this study, 84% of the patients who underwent definitive treatment achieved good outcomes, and 70% had no complication. Several studies compared the Hunt and Hess grades to demonstrate that patients in grades 1 to 3 had better outcomes than patients in grades 4 and 5. Likewise, this is also true in the present study. Conversely, patients with higher SAH grading scores both for Hunt and Hess and Fishers showed poor outcomes. As shown in the study results, patients with higher SAH scores had decreased survival. Among the subjects, 19 died. The three most common complications were clinical vasospasm, hydrocephalus, and pneumonia, respectively. Elderly patients in this study usually succumbed to healthcare-related pneumonia.

Association of SAH Grading Scores to Patient Outcomes

The most important advantage of the Hunt and Hess grading scale is that it is widely known in the neuroscientific community and that it is well-entrenched in the literature on SAH. It is also relatively easy to administer because multiple steps are not required to derive a comprehensive grade. The present study predicts the association of Hunt and Hess scale to patient outcomes. It showed that increased Hunt and Hess scores were associated with decreased patient survival. While thepresent study involved most patients with lower Hunt and Hess scores (Grade 1-3), hence this shows a limitation of the significance of the findings.

The Fisher grading scale uniquely shows the same association with patient outcomes. The Fisher scale is also intended to predict vasospasm risk. Likewise, in the study, it showed that a higher Fisher grade was associated with the incidence of clinical vasospasm of patients with a ruptured aneurysm. Scales that are based on imaging findings are also used to help forecast the development of complications of subarachnoid hemorrhages, such as vasospasm and ischemic stroke, or to predict clinical outcomes. The combination of the Hunt and Hess and the Fisher grade also benefits the process in predicting patient outcomes.

Overall, the study results showed that grading scales are predictive of patient outcomes. High SAH grading scores are associated with poor outcomes and decreased patient survival. While the data reviewed were prospectively collected, this study remains a retrospective review of a single institution registry. The study may not be representative of the general Philippine population given the fact that it was pooled from a single institution and that it still lacks some external validation. The study is only limited to the assessment of clinical outcome of patients prior to discharge as some patients were lost to follow up in the succeeding months.

Conclusion

Higher scores for Hunt and Hess grading scale and Fisher grading scale were associated with poor patient outcome. Higher Fisher grading scale was associated with the occurrence of clinical vasospasm among patients with ruptured aneurysm. Female sex also had higher aneurysm incidence with complex and more multiple aneurysms as compared to male sex.

Prompt diagnosis and early intervention in patients with aneurysmal subarachnoid hemorrhage portends better outcome. Timely referral of these patients to higher and capable centers also increases the chance of survival.

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