Correlation of Arrival Glasgow Coma Scale (GCS) to Outcome of Traumatic Subarachnoid Hemorrhage in Terms of Glasgow Outcome Score

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ABSTRACT

Background: Evidence regarding impact of arrival Glasgow Coma Scale (GCS) on functional outcome after traumatic SAH is scant. The objective of this study was to determine the correlation of arrival GCS on outcome of traumatic subarachnoid haemorrhage in terms of Glasgow outcome scale

Methods: This is a prospective observational study conducted at the department of Neurosurgery, Hayatabad Medical Complex Peshawar between February 2023 and July 2024. A total of 245 patients with traumatic SAH were included. Data was collected for patient demographics, arrival GCS and GOS at discharge. Spearman rank correlation was used to assess the correlation between arrival GCS and discharge GOS.

Results: In this study mean age was 42.5 ± 9.3 years. Fifty-eight percent patients were male and 42% were female. Twelve percent patients had GCS score range 3-5, 58% patients had GCS score range 6-10, 30% patients had GCS score range 11-15. Mean GCS was 8.82 with SD ± 3.115. Forty five percent patients had favorable outcome GOS (4-5), 55% patients had unfavorable outcome GOS (1-3). Mean GOS was 3.23 with SD ± 1.070. The Spearman's rank correlation coefficient was 0.125.

Conclusion: Our study shows a positive correlation of arrival Glasgow Coma Scale (GCS) on outcome of traumatic subarachnoid haemorrhage in terms of Glasgow outcome scale, however, this correlation was not sufficiently strong.

Keywords: Correlation, Glasgow Coma Scale (GCS), traumatic subarachnoid haemorrhage, Glasgow outcome scale

INTRODUCTION

Traumatic brain injury is one of the leading causes of death and disability worldwide. Pakistan has one of the highest incidences of brain trauma. The surge in motor vehicle use and lack of safety measures have compounded the problem of traumatic disability from head injury several folds. The incidence of traumatic brain injuries is estimated variously to range from 150-250 cases per 100,000 persons per year. The Glasgow comma scale is used to grade the severity of brain injury. Mild brain injury is graded with a GCS of 14 & 15, moderate brain injury ranges from GCS of 9 to 13 while severe traumatic brain injury is grouped into a GCS range of 8 or below.1

Traumatic subarachnoid haemorrhage (tSAH) is a serious condition which is shown by numerous studies to adversely affect the outcome in traumatic brain injuries in terms of prolonged morbidity and high mortality. The estimated incidence of tSAH varies widely due to differences in availability of advanced diagnostic studies as well as the lack of presence of specialized neurosurgical facilities. Its incidence is up to 28% of the traumatic brain injuries.2,3,4

Subarachnoid haemorrhage is graded both clinically and radiologically using pre-defined criteria. The most widely used clinical parameter used to determine the severity of SAH is the usage of GCS which grades the patient into severity of brain injury according to the three classes. The radiological criteria in wide use are the modified Fisher grading using computed tomography for traumatic subarachnoid haemorrhage. The clinical utility of both of these grading scales have been validated in multiple studies.5,6,7

Studies by Potts MB et al8 and Matis G et al9 has shown that the overall correlation between GCS and GOS did not reach significance (r = 0.18,p = 0.076) for patients with TBIs unless they are combined with broad outcome scales. These studies have also pointed out that without stratification for age and other factors, there is poor correlation of GCS to GOS.8,9

The GOS categorizes patients into favourable (GOS = 4, 5) and unfavourable (1, 2, 3) groups. Study by Paiva et al has shown that in45% (r = 0.45) of patients with traumatic SAH the outcome is favourable while 55% (r = 0.55) show unfavourable outcome, with a mortality rate of 19%. Similarly, this study has found a strong correlation between the thickness of haemorrhage with an overall poor prognosis. High incidence of prolonged morbidity was attributed to the presence of concomitant intraventricular haemorrhage.10

Another study by Levy et al found that traumatic SAH (tSAH) even in mild TBI confer increased odds (OR 8.7, p <0.0001) of

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admission to ICU in all age groups or significant disability in the 40 to 70 year age group. However, it showed that there is no difference between mortality rates of concussion group or mild TBI with tSAH.11

A Study by George et al in a multivariate analysis showed that the maximum thickness (mm) of traumatic SAH was independently associated with neurological outcome (OR 0.8, 95% CI 0.7–0.9) and death (OR 1.3, 95% CI 1.2–1.5) but not with the extent or location of haemorrhage. Another study by Parchani et al found the Glasgow Coma Scale (GCS) as independent predictor of mortality in TBI patients with tSAH.12,13

The above mentioned studies have demonstrated the predicting power of the presentation GCS and its relation to GOS as well as its weaknesses in predicting outcome. The rationale for the present study is therefore to investigate the true role of GCS when used to assess the outcome in terms of GOS in those patients who are admitted with tSAH. It will assess the correlation between the arrival GCS in tSAH and its association with outcome of patients in terms of GOS at discharge. Consequently, it will help us better delineate the various classes of SAH with the predictable outcome.

METHODOLOGY

A prospective observational study was conducted in the Department of Neurosurgery, Hayatabad Medical Complex, Peshawar, from February 2023 to July 2024. The study included patients aged 18–60 years who presented with traumatic subarachnoid haemorrhage (tSAH) and were admitted through the emergency department or outpatient department.

Patients aged 18–60 years with a radiologically confirmed diagnosis of traumatic SAH on computed tomography (CT) of the brain were eligible for inclusion. Patients with aneurysmal or spontaneous SAH and those who had received treatment at another healthcare facility for more than 24 hours before presentation were excluded. The eligibility criteria were applied consistently throughout the study to minimize potential selection bias and confounding.

Following admission, all eligible patients underwent a detailed history and neurological examination. The diagnosis of tSAH was confirmed by CT brain imaging. The Glasgow Coma Scale (GCS) score at initial presentation was recorded before definitive treatment. Routine laboratory investigations were performed as clinically indicated.

Management decisions, including the need for surgical intervention, were made by a consultant neurosurgeon who was a Fellow of the College of Physicians and Surgeons of Pakistan (FCPS) with at least five years of post-fellowship clinical experience. Patients were followed throughout their hospital stay until discharge. Functional outcome at discharge was assessed using the Glasgow Outcome Scale (GOS) by a consultant neurosurgeon with comparable qualifications. GOS scores of 4–5 were categorized as a favorable outcome, whereas scores of 1–3 were categorized as an unfavorable outcome.

Patient demographic and clinical information, including age, sex, initial GCS, and discharge GOS, was recorded using a predesigned data collection proforma. Clinical assessment and data recording were performed under the supervision of the neurosurgical team. Data were entered and analyzed using IBM SPSS Statistics version 20.0. Continuous variables, including age, initial GCS, and GOS, were summarized using mean and standard deviation (SD). Categorical variables, including sex and GOS-based outcome categories, were presented as frequencies and percentages.

The association between initial GCS and discharge GOS was assessed using Spearman's rank correlation coefficient because both variables were ordinal measures. Correlation analyses were additionally stratified by age and sex where appropriate. A two-sided p value of <0.05 was considered statistically significant. Results were presented using tables and appropriate graphical displays.

RESULTS

A total of 245 patients with traumatic subarachnoid haemorrhage (tSAH) were included in the analysis. The demographic characteristics, initial neurological status, and functional outcomes of the study population are presented in Tables 1–5.

Age Distribution

Among the 245 patients, 34 (13.9%) were aged 20–30 years, 78 (31.8%) were aged 31–40 years, 81 (33.1%) were aged 41–50 years, and 52 (21.2%) were aged 51–60 years. The mean age of the study population was 42.51 ± 9.29 years (Table 1).

Table 1. Age distribution of patients with traumatic subarachnoid haemorrhage (n = 245)

Age group (years)	Frequency (n)	Percentage (%)
20–30	34	13.9
31–40	78	31.8
41–50	81	33.1
51–60	52	21.2
Total	245	100.0
Mean ± SD	42.51 ± 9.29 years	

Sex Distribution

Of the 245 patients, 142 (58.0%) were male and 103 (42.0%) were female, indicating a higher proportion of male patients in the study population (Table 2).

Table 2. Sex distribution of patients with traumatic subarachnoid haemorrhage (n = 245)

Sex	Frequency (n)	Percentage (%)
Male	142	58.0
Female	103	42.0
Total	245	100.0

Initial Glasgow Coma Scale

The initial Glasgow Coma Scale (GCS) score was 3–5 in 29 (11.8%) patients, 6–10 in 142 (58.0%) patients, and 11–15 in 74 (30.2%) patients. The mean initial GCS score was 8.82 ± 3.12 (Table 3).

Table 3. Distribution of patients according to initial Glasgow Coma Scale score (n = 245)

Initial GCS score	Frequency (n)	Percentage (%)
3–5	29	11.8
6–10	142	58.0
11–15	74	30.2
Total	245	100.0
Mean ± SD	8.82 ± 3.12	

Glasgow Outcome Scale

At hospital discharge, 110 (44.9%) patients had a favorable functional outcome (GOS 4–5), whereas 135 (55.1%) had an unfavorable outcome (GOS 1–3). The mean GOS score at discharge was 3.23 ± 1.07 (Table 4).

Table 4. Functional outcome according to Glasgow Outcome Scale at discharge (n = 245)

GOS category	Outcome classification	Frequency (n)	Percentage (%)
4–5	Favorable	110	44.9
1–3	Unfavorable	135	55.1
Total		245	100.0

Mean ± SD	3.23 ± 1.07		

Correlation Between Initial GCS and Discharge GOS

Spearman's rank correlation analysis demonstrated a positive correlation between initial GCS and discharge GOS (Spearman's *r* = 0.125). However, the magnitude of the correlation was weak (Table 5).

Table 5. Correlation between initial Glasgow Coma Scale and discharge Glasgow Outcome Scale (n = 245)

Variable	Mean ± SD	Spearman's *r*	*p* value
Initial GCS	8.82 ± 3.12		
Discharge GOS	3.23 ± 1.07	0.125	[Insert exact p-value]

GCS: Glasgow Coma Scale; GOS: Glasgow Outcome Scale; SD: standard deviation.

DISCUSSION

Traumatic subarachnoid haemorrhage (tSAH) is a serious condition which is shown by numerous studies to adversely affect the outcome in traumatic brain injuries in terms of prolonged morbidity and high mortality. The estimated incidence of tSAH varies widely due to differences in availability of advanced diagnostic studies as well as the lack of presence of specialised neurosurgical facilities. Its incidence is up to 28% of the traumatic brain injuries.2,3,4,22 Subarachnoid haemorrhage is graded both clinically and radiologically using pre-defined criteria. The most widely used clinical parameter used to determine the severity of SAH is the usage of GCS which grades the patient into severity of brain injury according to the three classes. The radiological criteria in wide use are the modified Fisher grading using computed tomography for traumatic subarachnoid haemorrhage. The clinical utility of both of these grading scales have been validated in multiple studies. 16,17,18

Our study shows that mean age was 42.51 years with SD ± 9.287. Fifty-eight percent patients were male and 42% patients were female. Twelve percent patients had GCS score range 3-5, 58% patients had GCS score range 6-10, 30% patients had GCS score range 11-15. Mean GCS was 8.82 with SD ± 3.115. Forty five percent patients had favorable outcome GOS (4-5), 55% patients had unfavorable outcome GOS(1-3). Mean GOS was 3.23 with SD ± 1.070.

Studies by Potts MB et al8 and Matis G et al9 has shown that the overall correlation between GCS and GOS did not reach significance (r = 0.18,p = 0.076) for patients with TBIs unless they are combined with broad outcome scales. These studies have also pointed out that without stratification for age and other factors, there is poor correlation of GCS to GOS.8,9

The GOS categorizes patients into favourable (GOS = 4, 5) and unfavourable (1, 2, 3) groups. Study by Paiva et al has shown that in45% (r = 0.45) of patients with traumatic SAH the outcome is favourable while 55% (r = 0.55) show unfavourable outcome, with a mortality rate of 19%. Similarly, this study has found a strong correlation between the thickness of haemorrhage with an overall poor prognosis. High incidence of prolonged morbidity was attributed to the presence of concomitant intraventricular haemorrhage.10

Another study by Levy et al found that traumatic SAH (tSAH) even in mild TBI confer increased odds (OR 8.7, p <0.0001) of admission to ICU in all age groups or significant disability in the 40 to 70 year age group. However, it showed that there is no difference between mortality rates of concussion group or mild TBI with tSAH.11,20,21

Study by George et al in a multivariate analysis showed that the maximum thickness (mm) of traumatic SAH was independently associated with neurological outcome (OR 0.8, 95% CI 0.7–0.9) and death (OR 1.3, 95% CI 1.2–1.5) but not with the extent or location of haemorrhage. Another study by Parchani et al found the Glasgow Coma Scale (GCS) as independent predictor of mortality in TBI patients with tSAH.12,13,20

Gotoh et al14 prospectively examined the prognostic strength of the GCS in a series of 765 patients with SAH who had undergone surgery. Outcome was measured at 6 months using the GOS. There was a strong correlation between higher GCS and better outcome (r2=0.62; p< 0.001). However, there were only significant differences between GCS 14 and GCS 15, with no significant differences between the remaining adjacent GCS grades. Their breakpoints appeared to be 15 and 14, 11 and 10, and 7 and 6. There were significant differences between every group when the patients were classified by the WFNS Scale. The findings highlight the statistical problem of being able to differentiate patients on scales with increasing numbers of grades, especially when outcome is only assessed relatively crudely on a 5-point scale, such as the GOS.

Oshiro et al15 proposed compressing the 13 grades of the GCS into five grades: 1 (GCS: 15), 2 (GCS: 12–14), 3 (GCS: 9–11),4 (GCS: 6–8) and 5 (GCS: 3–5). Their grading scale was an attempt to correct the lack of prognostic significance between adjacent GCS grades by compressing the grades into five groups that had a statistically significant difference in outcome. The scale increases the number of steps required to produce a comprehensive grade from a GCS 4 to a GCS 5 (three grading, one summation, and one compression). In 15 prospectively evaluated patients, two raters had κ scores of 0.46, 0.41, and 0.27 for the new GCS-based system, the Hunt and Hess Scale, and the WFNS Scale, respectively. The authors retrospectively applied the GCS based scale to 291 patients and compared it to the WFNS and Hunt and Hess Scales.19 The GCS-based scale was the strongest predictor of discharge GOS, with an odds ratio of 2.6, compared to 2.3 for both the WFNS and Hunt and Hess Scales. On the other hand, the Hunt and Hess Scale was the strongest predictor of mortality, although this was believed to be less important because outcomes of patients with SAH are distributed from full recovery to death. The three scales had high agreement with each other, as judged by a κ statistic (0.63) indicating strong agreement. However, it should be noted that this analysis was based on discharge GOS, which may be an inadequate endpoint for final outcome after SAH. Additionally, the methods for determining the breakpoints for this system were not reported.

CONCLUSION

Our study shows a positive correlation of arrival Glasgow Coma Scale (GCS) on outcome of traumatic subarachnoid haemorrhage in terms of Glasgow outcome scale. However, the correlation is not strong for the two scales.

Ethical Approval

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the relevant Institutional Review Board/Ethics Committee of Hayatabad Medical Complex, Peshawar, Khyber Pakhtunkhwa, Pakistan.

Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Author Contributions

Conceptualization: Muhammad Ali Noman, Muhammad Imran
Methodology: Muhammad Ali Noman, Muhammad Imran, Mohammad Danial
Data Collection: Muhammad Ali Noman, Mohammad Danial
Formal Analysis: Muhammad Ali Noman, Muhammad Imran
Writing – Original Draft: Muhammad Danyal
Writing – Review & Editing: Muhammad Ali Noman, Muhammad Imran, Mohammad Danial

Informed Consent

Written informed consent was obtained from all participants before enrollment in the study.

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Conflict of Interest

The authors declare that they have no competing interests.

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Declaration of AI-Assisted Language Editing

Grammarly AI was used for sentences and language correction and after that approved by all authors.

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