Original Research

CORRELATION OF STRESS HYPERGLYCEMIA RATIO WITH SEVERITY AND SHORT-TERM OUTCOMES IN ACUTE STROKE PATIENTS

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ABSTRACT

Background: Stress hyperglycemia is a common metabolic response in acute stroke and is associated with poor neurological outcomes. Conventional glucose measurements often fail to differentiate acute stress-induced hyperglycemia from chronic glycemic status. Stress Hyperglycemia Ratio (SHR), derived from admission glucose and HbA1c, has emerged as a more reliable prognostic biomarker in acute stroke patients.

Aim: To evaluate the correlation between Stress Hyperglycemia Ratio and severity of stroke along with short-term clinical outcomes in patients with acute stroke.

Materials and Methods: This hospital-based observational study was conducted in the Department of General Medicine, M.G.M. Medical College and M.Y. Hospital, Indore, among 238 patients diagnosed with acute stroke. Clinical severity was assessed using Glasgow Coma Scale (GCS) and National Institutes of Health Stroke Scale (NIHSS). SHR was calculated using admission blood glucose and HbA1c-derived estimated average glucose. Outcomes during hospitalization were categorized as improvement, no change, deterioration, or death. Statistical analysis was done by appropriate statistical software.

Results: The mean age of study participants was 56.4 years and males constituted 66.4% of the cohort. Most patients had ischemic stroke (89.5%). SHR showed a statistically significant positive correlation with NIHSS score ($r = 0.164$, $p = 0.011$). Higher SHR values were associated with poor clinical outcomes including deterioration and mortality ($r = -0.352$, $p < 0.0001$). Patients who deteriorated had the highest mean SHR (1.50), while those who improved had the lowest mean SHR (1.26).

Conclusion: Stress Hyperglycemia Ratio appears to be a useful prognostic biomarker in acute stroke patients. Elevated SHR is associated with increased stroke severity and worse short-term outcomes. SHR may serve as a practical and cost-effective tool for early risk stratification and prognostication in acute stroke management.

Keywords: Stress Hyperglycemia Ratio, Acute Stroke, NIHSS, Stroke Severity, Clinical Outcome, Hyperglycemia.

INTRODUCTION

Stroke is a major global health burden and remains one of the leading causes of mortality and long-term disability worldwide. The Global Burden of Disease 2021 study reported stroke as the second leading cause of death and the third leading cause of disability-adjusted life years globally. Increasing prevalence of hypertension, diabetes mellitus, obesity, smoking, and sedentary lifestyle has significantly contributed to rising stroke incidence, particularly in low- and middle-income countries.[1,2]

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Stress hyperglycemia is a transient elevation of blood glucose occurring during acute physiological stress such as stroke, trauma, or sepsis. Acute hyperglycemia during stroke is associated with increased infarct size, neuronal injury, oxidative stress, endothelial dysfunction, and poor neurological recovery.[3,4] Approximately one-third of acute ischemic stroke patients develop stress hyperglycemia even without pre-existing diabetes mellitus.[5] Traditional assessment using admission blood glucose alone has limited prognostic value because it does not account for chronic glycemic status. In diabetic individuals, elevated glucose may merely reflect chronic poor glycemic control rather than acute stress response. To overcome this limitation, newer indices such as Stress Hyperglycemia Ratio (SHR), glycemic gap, and glucose-to-HbA1c ratio have been introduced.[6]

Stress Hyperglycemia Ratio (SHR) is derived from admission blood glucose and HbA1c levels and helps in assessing stress-related hyperglycemia more accurately during acute illness. Recent studies have shown that higher SHR values are associated with poor neurological recovery, increased mortality, and adverse functional outcomes in patients with acute ischemic stroke.[7–9] Despite increasing evidence regarding the prognostic significance of SHR, limited Indian data are available evaluating its association with stroke severity and short-term outcomes. Therefore, the present study was conducted to assess the relationship between SHR, stroke severity, and short-term clinical outcomes in acute stroke patients admitted to a tertiary care center in Central India.

MATERIALS AND METHODS

The present prospective observational study was conducted in the IPD and MICU of M.G.M. Medical College and M.Y.H. and Associated Hospitals, Indore, after approval from the institutional ethics committee. The study duration was one year from the date of ethical approval. A total of 238 acute stroke patients fulfilling the inclusion and exclusion criteria were enrolled in the study. Patients presenting with acute stroke as per American Stroke Association (ASA) criteria and confirmed radiologically by CT/MRI brain were evaluated. Detailed clinical examination including Glasgow Coma Scale (GCS) and National Institutes of Health Stroke Scale (NIHSS) scoring was performed. Routine biochemical investigations including blood glucose and HbA1c were carried out, and Stress Hyperglycemia Ratio (SHR) was calculated to assess its correlation with stroke severity and short-term clinical outcomes.

Inclusion Criteria

- Patients aged more than 18 years.
- Patients with first episode of acute cerebrovascular accident.
- Patients diagnosed clinically and radiologically with ischemic or hemorrhagic stroke.
- Patients admitted within 72 hours of symptom onset.

Exclusion Criteria

- Patients with transient ischemic attack.
- Patients with traumatic intracranial hemorrhage.
- Patients with severe systemic illness including sepsis, chronic liver disease, or malignancy.
- Already known type 2 diabetes mellitus patients
- Patients on steroid therapy.
- Patients with incomplete laboratory or radiological data.

Data Collection

Detailed clinical history, demographic data, risk factors, and neurological examination findings were recorded. Stroke severity was assessed using:

- Glasgow Coma Scale (GCS)
- National Institutes of Health Stroke Scale (NIHSS)

Laboratory investigations were included: Random blood glucose, HbA1c, Complete blood count, renal function tests and Lipid profile

Outcome Assessment

Short-term clinical outcome during hospitalization was categorized into:

- Improvement
- No change
- Deterioration
- Death

Statistical Analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS) software. Quantitative variables were expressed as mean ± standard deviation. Qualitative variables were expressed as percentages. Pearson's correlation coefficient, biserial correlation, chi-square test, ANOVA, and p-values were used for statistical analysis. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Age and Gender-wise Distribution of Study Participants

Variables		Frequency (n)	Percentage (%)
Age	31-40	5	2.1%
	41-50	82	34.5%
	51-60	74	31.1%
	61-70	63	26.5%
	71-80	14	5.9%
Gender	Female	80	33.6%
	Male	158	66.4%

The majority of study participants belonged to the 41–60 years age group, indicating a higher prevalence of acute stroke among middle-aged individuals. Male patients constituted 66.4% of the study population, demonstrating a significant male predominance in acute stroke cases. (Table 1)

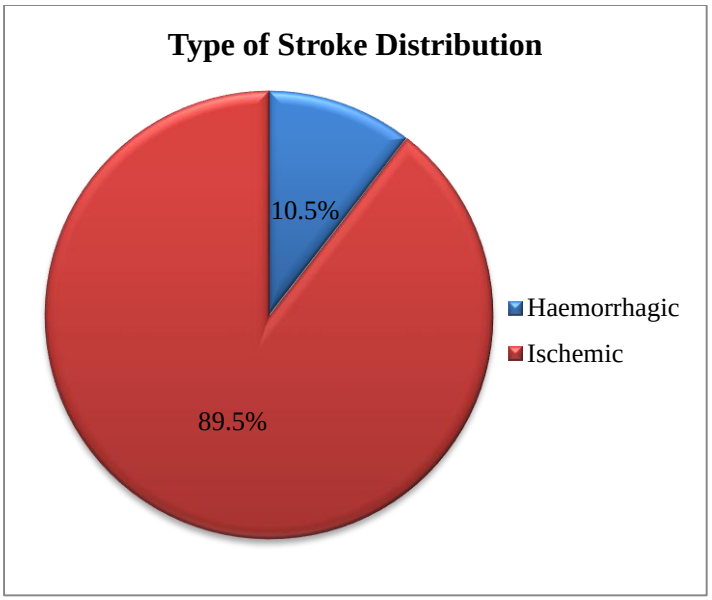

Figure 1: Distribution of Stroke Types among Study Participants

The majority of patients in the present study had ischemic stroke (89.5%), whereas hemorrhagic stroke accounted for only 10.5% of cases. This finding suggests that ischemic stroke was the predominant subtype observed among patients admitted with acute cerebrovascular accident. (Figure 1)

Table 2: Glasgow Coma Scale (GCS) Severity Distribution at Admission

GCS Category	Frequency (n)	Percentage (%)
Severe (3–8)	50	21%
Moderate (9–12)	67	28.2%
Mild (13–15)	121	50.8%

The Glasgow Coma Scale (GCS) assessment at admission showed that the majority of patients (50.8%) had mild neurological impairment with GCS scores between13–15. Moderate impairment was observed in 28.2% patients, while 21.0% had severe impairment of consciousness. (Table 2)

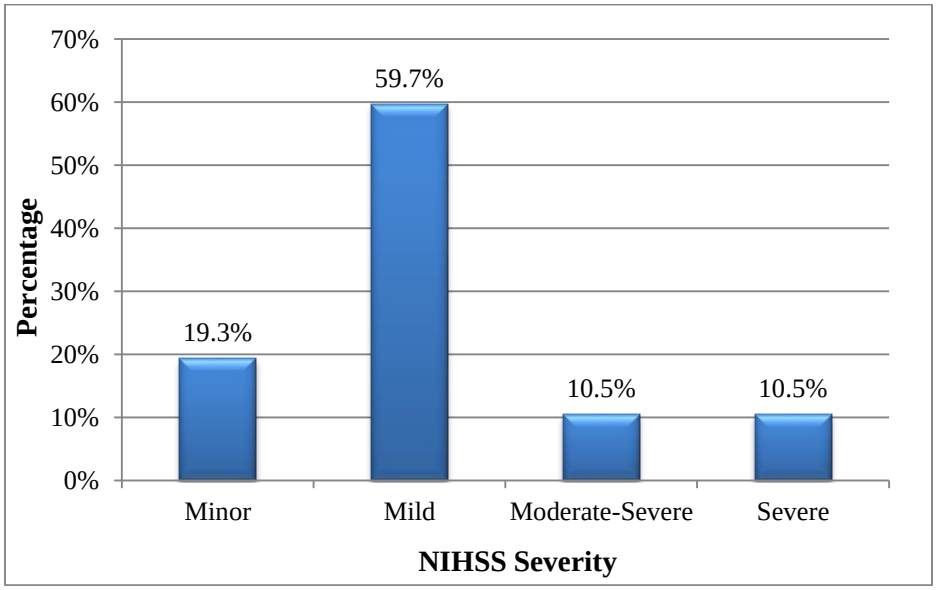

Figure 2: National Institutes of Health Stroke Scale (NIHSS) Severity Classification

NIHSS scoring revealed that most stroke patients belonged to the lower severity categories. Nearly 79% patients were classified as Minor or Mild stroke severity, whereas only 21% had Moderate-Severe or Severe neurological deficits. (Figure 2)

Table 3: Association between Stress Hyperglycemia Ratio (SHR) and Clinical Outcome (One-Way ANOVA)

Outcome	N	SHR Mean	SD	P-Value
Death	50	1.423	0.1925	<0.0001
Deterioration	46	1.503	0.1888	
Improvement	73	1.259	0.1137	
No change	69	1.313	0.126	

Patients who experienced clinical deterioration had the highest mean SHR value (1.503), followed by patients who died (1.423). In contrast, patients who showed clinical improvement had the lowest mean SHR (1.259). The statistically significant p-value (<0.0001) indicates a strong association between elevated SHR and poor short-term clinical outcomes in acute stroke patients. (Table 3)

Table 4: Correlation Between Stress Hyperglycemia Ratio (SHR) and NIHSS Score (Pearson's Correlation)

Variables	r	P-Value
SHR and NIHSS	0.164	0.011

A statistically significant positive correlation was observed between SHR and NIHSS score (r = 0.164, p = 0.011). This finding suggests that higher SHR values were associated with increasing stroke severity and worsening neurological deficits among acute stroke patients.

Table 5: Correlation between Stress Hyperglycemia Ratio (SHR) and Clinical Outcome (Biserial Correlation)

Variables	r	P-Value
SHR and outcome	-0.352	<0.0001

A statistically significant negative correlation was observed between SHR and clinical outcome (r = -0.352, p <0.0001). The negative correlation was observed because worsening clinical outcomes were coded inversely during statistical analysis. Higher SHR values were associated with adverse outcomes such as neurological deterioration and mortality, whereas lower SHR values were associated with better recovery and clinical improvement.

DISCUSSION

Stress hyperglycemia is increasingly being recognized as an important predictor of outcome in acute stroke patients. SHR provides a more reliable assessment of acute metabolic stress because it incorporates chronic glycemic status through HbA1c adjustment.[10]

In the present study, the mean age of patients was 56.4 years with significant male predominance. Similar demographic observations with male predominance among stroke patients have been reported in previous stroke studies.[11,12] The younger age profile observed in the present study may reflect increasing prevalence of metabolic syndrome, hypertension, and diabetes in the Indian population.

A significant positive correlation was observed between SHR and NIHSS score (r = 0.164, p = 0.011), indicating that elevated SHR is associated with increased stroke severity. Similar findings were reported by Chen et al. and Huang et al., who demonstrated that higher SHR values predicted severe neurological deficits and poor functional outcomes after acute ischemic stroke.[13,14]

In this study, higher SHR values were associated with poorer short-term clinical outcomes. Patients with deterioration and mortality had significantly higher SHR values compared to patients who improved clinically. These findings are consistent with studies by Shen et al., Zhang et al., and Merlino et al., who reported that elevated SHR independently predicts mortality, neurological worsening, and poor recovery following acute stroke.[15–17]

Hyperglycemia during acute stroke may worsen neurological injury through mechanisms such as oxidative stress, inflammation, endothelial dysfunction, and blood-brain barrier damage.[12] Acute hyperglycemia also impairs collateral circulation and increases infarct expansion, thereby worsening neurological injury.

The present study supports the utility of SHR as a simple, inexpensive, and clinically useful prognostic marker. Unlike isolated admission glucose measurements, SHR better differentiates acute stress response from chronic hyperglycemia and may therefore provide superior risk stratification.[14]

However, this study had certain limitations. It was a single-center observational study with relatively short follow-up duration. Dynamic glucose variability during hospitalization was not assessed. Larger multicentric prospective studies are needed to validate the prognostic role of SHR in diverse stroke populations.

CONCLUSION

The findings of the present study suggest that Stress Hyperglycemia Ratio is associated with stroke severity and short-term clinical outcomes in acute stroke patients. Elevated SHR correlates with higher NIHSS scores, clinical deterioration, and mortality. SHR appears to be a simple and useful marker for

identifying stroke patients who are at higher risk of poor clinical outcomes.

Assessment of SHR at admission may help clinicians identify high-risk patients early and improve monitoring and management during hospitalization. Further large-scale prospective studies are recommended to establish standardized SHR cutoff values and integrate SHR into routine stroke prognostic models.

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