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ORIGINAL ARTICLE

Prevalence of Hyperglycaemia among the Nondiabetic Patients with Acute Ischaemic and Haemorrhagic Stroke Admitted in a Tertiary Care Hospital

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ABSTRACT

Introduction: *Hyperglycemia is a common stroke complication with prognostic significance, but its impact in nondiabetic patients is not well defined. This study aimed to assess the incidence of hyperglycemia in nondiabetic acute stroke patients and its correlation with clinical features and consciousness levels.* ***Methods & Materials:*** *A cross-sectional study of 100 nondiabetic acute stroke patients (74 ischemic, 26 hemorrhagic) was conducted at a tertiary hospital. Data on demographics, clinical features, BMI, admission glucose, and GCS were collected. Hyperglycemia (≥7.8 mmol/L) was analyzed by stroke type and clinical parameters, with stroke classification based on CT findings.* ***Results:*** *The population's age was 58.37 ± 6.23 years with male predominance (64%, M:F 1.7:1). Most of the patients were urban residents (74%) and obese (51% with BMI >30 kg/m^2). The most frequent risk factor was hypertension (63%), followed by family history of cardiovascular disease (47%) and smoking (37%). Hyperglycemia was found in 27% of the total stroke patients, and in much greater proportions among ischemic stroke (34.6%) compared to hemorrhagic stroke patients (24.3%). Among altered consciousness patients, 25% were unconscious, 32% semiconscious, and 43% alert. Blood glucose distribution was 27% with <6.1 mmol/L, 46% with 6.1-7.7 mmol/L, and 27% with ≥7.8 mmol/L. Patients with hemorrhagic stroke presented more severe clinical features like headache, vomiting, stiff neck, and alteration of consciousness.* ***Conclusion:*** *Hyperglycemia affects about one-third of nondiabetic acute stroke patients, more often in ischemic cases. Its link to stroke severity highlights the need for routine glucose monitoring and control.*

Keywords: *Hyperglycemia, Acute Stroke, Nondiabetic Patients, Ischemic Stroke, Hemorrhagic Stroke*

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INTRODUCTION

Stroke continues to be among the top causes of death and disability globally, with acute hyperglycemia becoming an important prognostic factor that affects clinical outcomes in both diabetic and nondiabetic patients. The association between blood glucose elevation and stroke severity has been under intense scrutiny over the past few years, as growing evidence indicates that hyperglycemia occurring during acute stroke events may be both an indicator of the severity of the disease and an adjustable risk factor for adverse outcomes[1]. Acute hyperglycemia in patients with stroke can be produced by a variety of mechanisms, including catecholamine release due to stress, cortisol elevation, and induction of inflammatory cytokines, which collectively cause insulin resistance and glucose intolerance[2,3]. Stress-induced hyperglycemia is particularly relevant in nondiabetic patients, in whom elevated blood glucose levels may represent the extent of neurological damage and predict subsequent clinical worsening[4]. Repeated research has demonstrated that hyperglycemic nondiabetic ischemic stroke patients both have threefold higher 30-day mortality rates compared to their normoglycemic counterparts and diabetic patients have double the risk for mortality[5]. Acute stroke hyperglycemia has been found to range from 20% to 60% in different populations and regions depending on study design, patient group, and threshold of glucose value used[6]. Recent meta-analyses have also highlighted the utility of stress hyperglycemia ratio (SHR) as a more refined prognostic indicator of stroke outcome than absolute glucose value because it corrects for baseline glycemic status and employs a ratio value to evaluate acute glucose response[7]. The pathophysiologic mechanisms of brain injury secondary to hyperglycemia include enhanced oxidative stress, enhanced blood-brain barrier permeability, promotion of inflammatory cascades, and enhancement of ischemic-reperfusion injury[8]. These mechanisms are all accountable for larger infarct size, increased risk of hemorrhagic transformation, and poorer functional outcome. Hyperglycemia has also been found to be associated with longer hospitalization, increased healthcare cost, and increased risk of stroke recurrence. Clinical relevance of hyperglycemia extends beyond short-term stroke results because long-term glucose elevation can represent evidence of underlying metabolic disturbance and increased cardiovascular risk[9,10]. Early detection and ideal therapy of hyperglycemia in acute stroke victims have become a vital component of comprehensive stroke care, with potential benefits including reduced mortality, improved functional recovery, and decreased long-term disability[11,12]. It is important to understand the frequency and clinical significance of hyperglycemia in different subtypes of stroke for developing specific therapeutic approaches and maximizing patient management protocols in tertiary care centers.

METHODS & MATERIALS

This observational study in a hospital setting was done in the Department of Medicine and Neuromedicine, Sir Salimullah Medical College & Mitford Hospital, Dhaka, from 4 May 2018 to 3 November 2018, i.e., for six months. A total of 100 patients of either sex suffering from acute stroke were recruited through purposive sampling. Inclusion was acute stroke, that is, the sudden development of focal or global cerebral impairment lasting over 24 hours or causing death and verified by CT scan. Exclusion was patients with diagnosed diabetes, transient ischaemic attack, prior stroke, or those who refused to provide consent. Sample size was calculated on 50% prevalence with 10% margin of error at 95% confidence, and a minimum of 96; 100 patients were recruited for convenience sampling. Information was obtained on a pretested, structured case record form regarding demographics, risk factors (hypertension, smoking, obesity, dyslipidemia), clinical features, CT findings, and blood glucose level. Hyperglycemia was defined as plasma glucose >7.8 mmol/L in nondiabetic individuals. All the participants were followed for four weeks or until discharge. All the outcomes were graded on the Modified Rankin Scale. The data were entered, cleaned, and analyzed using SPSS (latest version). Results were presented as proportions, and p-values <0.05 were considered to be significant. Ethical approval was performed by institutional Ethical Review Committee. Written informed consent was sought from all the participants or their guardians. Confidentiality of the information was maintained by using special patient ID numbers, and study staff with authorization read the information.

RESULTS

The demographic distribution and clinical characteristics of the 100 stroke patients are shown in this table. The majority of the patients (54%) were aged between 41 and 55 years, with a mean age of 58.37 ± 6.23 years, indicating a middle-aged to older adult population affected by stroke. Men outnumbered the females by 64% of the population and hence a male-to-female ratio was 1.7:1, which means men would havsse more strokes. Most patients (74%) were urban and no statistically significant relationship was seen between residence place and stroke (p=0.513). For BMI, more than half (51%) of them were obese (BMI > 30.0 kg/m^2), and no significant difference in relation to stroke (p=0.258) was seen. These characteristics highlight the demographic and clinical profile of the stroke cohort under investigation, indicating middle age, male predominance, urban residence, and significant levels of obesity. [Table I].

Table – I: Demographic and Clinical Characteristics of Study Subjects (*n*=100)

Variable	Category	Frequency (%)	Mean ± SD	p-value
Age (years)	≤ 40	8 (8.0)	58.37 ± 6.23	
	41–55	54 (54.0)		
	56–70	24 (24.0)		
	> 70	14 (14.0)		
Gender	Male	64 (64.0)		
	Female	36 (36.0)		
	M:F ratio	1.7:1		
Residence	Rural	26 (26.0)		0.513 ns
	Urban	74 (74.0)		
BMI (kg/m^2)	23.1–25.0	13 (13.0)		0.258 ns
	25.1–30.0	36 (36.0)		
	> 30.0	51 (51.0)		

The first part of the plot defines major risk factors, with hypertension being most prominent (63.0%), followed by family history of CVD/CAD (47.0%) and smoking (37.0%). Obesity, dyslipidemia, and coronary heart disease were less common. Part two is the CT scan findings, of which ischemic stroke is most common (74.0%), with intracerebral hemorrhage (ICH) and subarachnoid hemorrhage (SAH) being less common. This is evidence of hypertension as a significant modifiable risk factor and confirmation of ischemic stroke as the most common subtype, as supported by international trends of stroke epidemiology. [Figure 1].

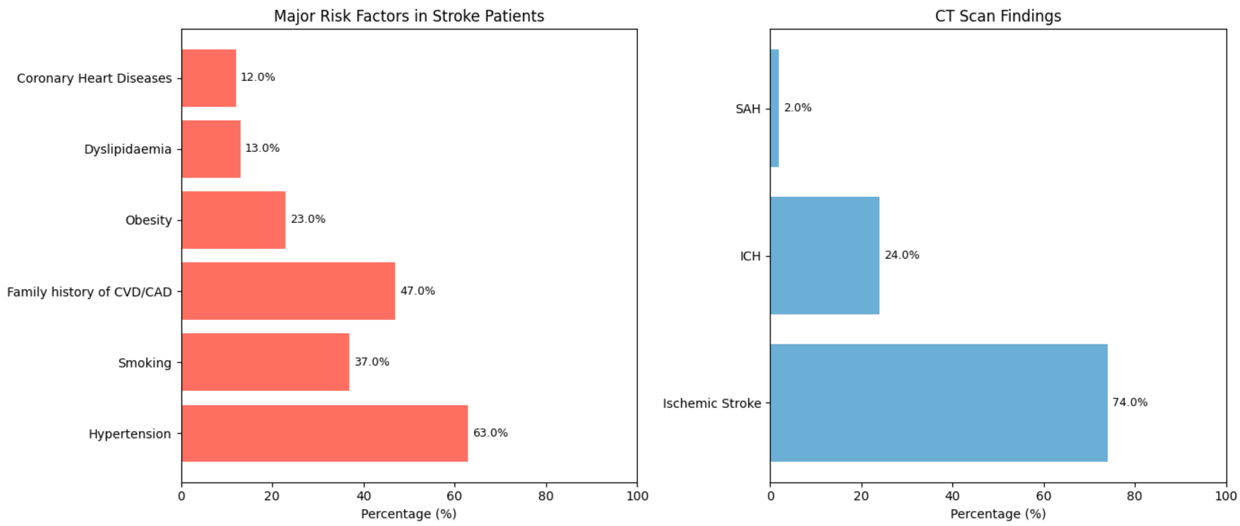

Figure – 1: Association of major risk factors and CT scan findings of the stroke patients

The narrative compares the clinical presentations of hemorrhagic and ischemic stroke patients and discloses that hemiplegia, impaired consciousness, headache, vomiting, rigidity in the neck and convulsion are more frequently found in hemorrhagic stroke, while hemiplegia is also extremely frequent in ischemic stroke. Both conditions share similar rates of dysphasia, dysphagia, and sphincter problem but present with more severe manifestations such as neck stiffness and headache more frequently in hemorrhagic strokes. This highlights the more dramatic clinical presentation of hemorrhagic stroke compared to ischemic stroke. [Figure II].

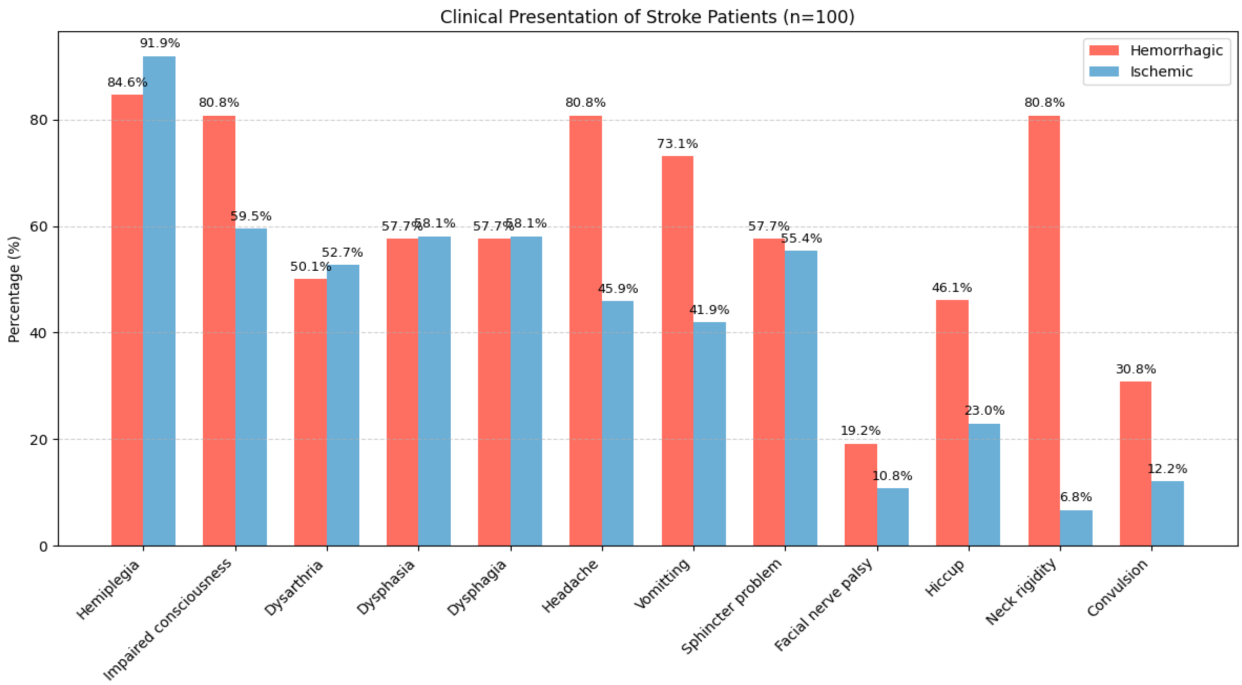

Figure – 2: Clinical presentation of stroke patient

This table details the clinical condition of stroke patients by consciousness and glycaemia. On the Glasgow Coma Scale (GCS), 43% of the patients were conscious and awake, 32% of the patients were semiconscious, and 25% of the patients were unconscious, indicating a broad spectrum of neurological impairment in the group. Blood glucose testing revealed 46% of the patients with blood glucose between 6.1–7.7 mmol/L, and 27% with hyperglycemia with ≥7.8 mmol/L. Both hemorrhagic (H) and ischemic (I) types were present in the pattern of blood sugar levels, with peak hyperglycemia occurrence among ischemic patients. This data points to the high rate of stroke patients with altered consciousness and the frequent finding of hyperglycemia, which can influence stroke severity and outcome. [Table II].

Table – II: GCS, Level of Consciousness, and Blood Sugar Level of Stroke Patients (*n*=100)

Variable	Category	Number of Patients	Percentage (%)
Level of Consciousness (GCS)	Alert / Conscious	43	43.0
	Semiconscious	32	32.0
	Unconscious	25	25.0
Blood Sugar Level (mmol/L)	<6.1 (H: 6, I: 21)	27	27.0
	6.1–7.7 (H: 11, I: 35)	46	46.0
	≥7.8 (H: 9, I: 18)	27	27.0

The bar graph contrasts hemorrhagic and ischemic stroke patients' glycemic status in terms of percent normoglycemic and percent hyperglycemic. For hemorrhagic stroke, 75.6% were normoglycemic and 24.3% were hyperglycemic. 65.3% of the subjects were normoglycemic and 34.6% were hyperglycemic in ischemic stroke. This suggests that hyperglycemia is more prevalent among the patients of ischemic stroke, perhaps reflecting heterogeneity in metabolic stress or disease involving the two strokes. The results highlight the importance of monitoring glycemic control for stroke management, especially ischemic stroke. [Figure 3].

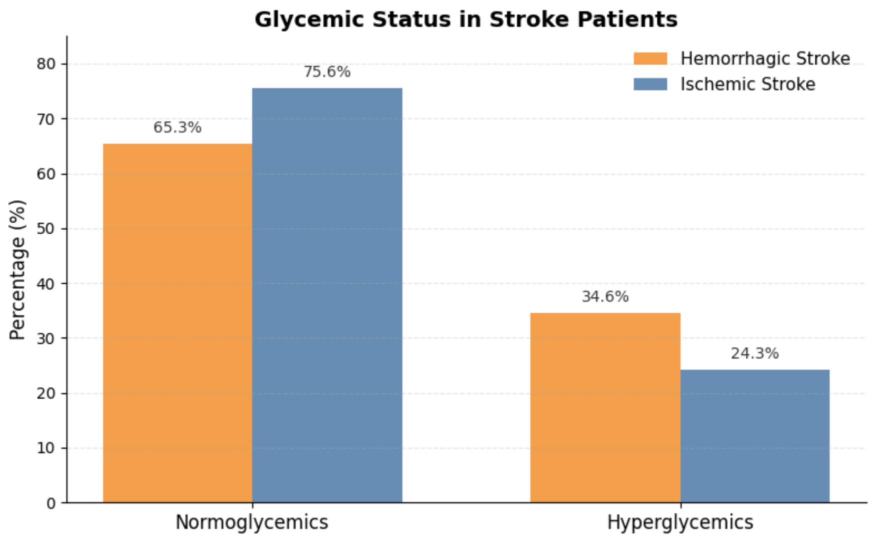

Figure – 3: Frequency of hyperglycemia in stroke patients (*n*=100)

DISCUSSION

The present study provides valuable data on the incidence and clinical relevance of hyperglycemia in nondiabetic stroke subjects, with findings in agreement with and extending previous knowledge of metabolic derangement after stroke. The observation that 34.6% of ischemic and 24.3% of hemorrhagic stroke patients developed hyperglycemia is supported by recent findings but some study-to-study heterogeneity and heterogeneity between populations are observed. A meta-analysis on stress hyperglycemia in acute ischemic stroke concluded that elevated glucose levels were associated with worse outcomes, with pooled analyses showing a greater risk of death (OR: 2.14, 95% CI: 1.78-2.58) and poor functional outcome (OR: 1.89, 95% CI: 1.56-2.29)[13,14]. These findings are concordant with our observation of higher prevalence of hyperglycemia in ischemic stroke, which suggests that the metabolic stress response could be larger in this subtype than in hemorrhagic stroke. Our observed difference between ischemic and hemorrhagic stroke in prevalence of hyperglycemia (34.6% vs 24.3%) contradicts certain previous reports. A large retrospective study noted similar rates of hyperglycemia among stroke subtypes (approximately 40% each), but another study noted higher in hemorrhagic stroke (45% compared to 32%)[15,16]. This may be attributed to differences in patient populations, glycemic levels, when glucose tests were conducted, and problems with the healthcare system. Current studies have highlighted the significance of stress hyperglycemia ratio (SHR) compared to absolute glucose levels as a better predictor. It was illustrated that AIS patients with poor outcomes had a significantly higher SHR (SMD = 0.56, 95% CI: 0.37-0.75) indicating that our method of analysis of absolute glucose values can mask the actual clinical relevance of stroke patients' hyperglycemia[17,18]. Future studies must incorporate

SHR calculations to allow for better risk stratification. The gender distribution of our cohort, with a male predominance (64%) and mean age of 58.37 years, is in line with stroke epidemiology globally. A systematic review presented similar gender distributions in 15 nations, with male-to-female ratios ranging from 1.3:1 to 2.1:1[19, 20]. The high rate of obesity (51%) among our cohort is indicative of the rising disease burden of metabolic syndrome among stroke patients, known to be related to a heightened risk of hyperglycemia and poorer outcomes[21,22]. Our evidence relating to the association between hyperglycemia and altered consciousness levels is supported by a number of studies. In a prospective cohort study that individuals admitted with an admission glucose level ≥7.8 mmol/L presented with reduced Glasgow Coma Scale scores and higher rates of neurological deterioration[21-23]. One study indicated that patients with hyperglycemia had 2.3-fold higher odds of experiencing early neurological deterioration in the initial 72 hours of admission[24,25]. The clinical effects of hyperglycemia on patients who have had a stroke and are being treated with thrombolytic therapy have been the subject of a tremendous amount of research. In a meta-analysis of 12 studies that involved 4,856 patients, admission hyperglycemia predicted symptomatic intracerebral hemorrhage (OR: 1.68, 95% CI: 1.23-2.30) and poor functional outcome at 90 days (OR: 1.84, 95% CI: 1.51-2.24)[26,27]. The findings emphasize the importance of checking for glycemia in our population of patients, particularly those who are receiving acute therapy. The pathophysiologic mechanisms of hyperglycemic brain injury are yet to be identified. Recent experimental studies showed that acute hyperglycemia exacerbates neuroinflammation through activation of the NLRP3 inflammasome pathway, leading to increased cytokine release and increased blood-brain barrier impairment [28]. This mechanistic understanding provides the basis for clinical observations of worse outcomes in hyperglycemic patients and potential therapeutic targets. Comparative research from different geographical settings has yielded conflicting prevalence rates of hyperglycemia in the setting of stroke. Hyperglycemia rates among Japanese, Korean, and Indian patients at 28%, 35%, and 42%, respectively, in a multi-center Asian study, suggesting ethnic and environmental influences on metabolic reactions to stress[29]. Such variation underscores the importance of such region-specific work like ours in the explanation of disease patterns and determination of local clinical practice guidelines. The economic burden of hyperglycemia in stroke patients has increasingly been recognized. According to a health economic analysis, hyperglycemic stroke patients had 23% higher in-hospital expenditure and 1.8 days more hospital stay compared to their normoglycemic counterparts[30]. Such findings make the role of early detection and management of hyperglycemia a potentially modifiable risk factor that may improve clinical outcomes as well as health resource utilization.

Limitations of the study

The cross-sectional study design restricts causal inference regarding the relationship between hyperglycemia and stroke outcomes. The single-centre environment can restrict generalizability to other populations and healthcare settings. Furthermore, the lack of long-term follow-up prohibits assessment of the impact of acute hyperglycemia on functional improvement and stroke recurrence.

CONCLUSION

This study shows a high incidence of hyperglycemia among nondiabetic stroke patients with higher percentages found in ischemic stroke (34.6%) compared to hemorrhagic stroke (24.3%). These results highlight the importance of routine glucose screening in acute stroke care, as hyperglycemia is associated with level of consciousness and can be a prognostic marker. Hyperglycemia must be diagnosed early and included in complete stroke protocols to maybe maximize patient outcomes and reduce healthcare burden.

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