METABOLIC DYSREGULATION IN ACUTE STROKE A INSIGHTS INTO GLUCOSE AND LIPID ABNORMALITIES FOR IMPROVED OUTCOMES

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ABSTRACT

Background:

Stroke is a leading cause of morbidity and mortality worldwide, with significant contributions from metabolic abnormalities such as dyslipidemia and diabetes mellitus (DM). Stress-induced hyperglycemia in acute stroke is a common yet underdiagnosed condition that may reflect undiagnosed DM or impaired glucose metabolism. Dyslipidemia, characterized by abnormal lipid profiles, is also a major risk factor for stroke. This study aims to assess the prevalence of hyperglycemia and dyslipidemia among acute stroke patients in India.

Methods:

A cross-sectional study was conducted over one year in a tertiary hospital. Adults presenting with acute stroke within three days of onset were included. Demographic, clinical, and biochemical data, including blood glucose, glycosylated hemoglobin (HbA1c), and lipid profiles, were collected. Patients were classified based on glycemic status (euglycemia, stress hyperglycemia, known DM, and undiagnosed DM) and lipid abnormalities (elevated LDL-C, low HDL-C, hypertriglyceridemia, and elevated total cholesterol). Statistical analyses were performed to identify significant findings.

Results:

Of the 150 patients included, 78% had ischemic stroke, and 22% had hemorrhagic stroke. Glycemic abnormalities were prevalent, with 50% of patients being euglycemic, 23.3% having known DM, and 13.3% each having stress hyperglycemia and undiagnosed DM. Dyslipidemia was common, with elevated LDL-C (56.7%) and low HDL-C (50%) being the most frequent abnormalities. Elevated total cholesterol and hypertriglyceridemia were noted in 30% and 23.3% of patients, respectively.

Conclusion:

Metabolic abnormalities, including hyperglycemia and dyslipidemia, are prevalent in stroke patients and significantly contribute to stroke risk and outcomes. Routine screening for glucose and lipid abnormalities in stroke patients is essential for early detection and management. This study underscores the importance of integrating metabolic assessments into acute stroke care to improve outcomes and reduce the burden of recurrent cerebrovascular events.

Keywords: Acute stroke; Hyperglycemia; Stress hyperglycemia; Diabetes mellitus; Dyslipidemia; Lipid profile abnormalities; Metabolic screening.

Introduction

Stroke is a leading cause of morbidity and mortality worldwide, ranking as the third most common cause of death after coronary heart disease and cancer, particularly among the elderly. In India, stroke constitutes a significant public health challenge, with increasing incidence due to the aging population and lifestyle changes. Despite advancements in medical care, stroke continues to impose a substantial burden on healthcare systems, with high rates of disability and reduced quality of life among survivors. Identifying and addressing modifiable risk factors for stroke is, therefore, critical to improving outcomes and reducing its societal impact(1,2).

Metabolic abnormalities, including dyslipidemia and hyperglycemia, are well-documented risk factors for stroke. Hyperglycemia, observed in individuals with and without prior diabetes mellitus (DM), can occur as a transient response to the physiological stress of acute stroke or as a marker of undiagnosed glucose metabolism disorders. Stress-induced hyperglycemia has been associated with poorer functional recovery and higher mortality rates in stroke patients. Similarly, dyslipidemia, characterized by elevated low-density lipoprotein cholesterol (LDL-C) and reduced high-density lipoprotein cholesterol (HDL-C), is a major contributor to atherosclerosis and subsequent stroke risk(3,4).

In low- and middle-income countries like India, the prevalence of undiagnosed metabolic disorders remains high, highlighting a critical need for opportunistic screening during acute medical events like stroke. Early detection of glycemic and lipid abnormalities in stroke patients presents an opportunity for timely interventions that can improve short- and long-term outcomes(5,6).

This study aims to assess the prevalence of hyperglycemia, including stress hyperglycemia and undiagnosed DM, as well as dyslipidemia in patients presenting with acute stroke. By providing insights into the metabolic profile of stroke patients in India, this research underscores the importance of integrated metabolic and cardiovascular care in reducing the burden of stroke and improving patient outcomes.

Materials and Methods

This cross-sectional study was conducted over one year at a tertiary teaching hospital india, focusing on the evaluation of metabolic abnormalities, particularly glycemic and lipid

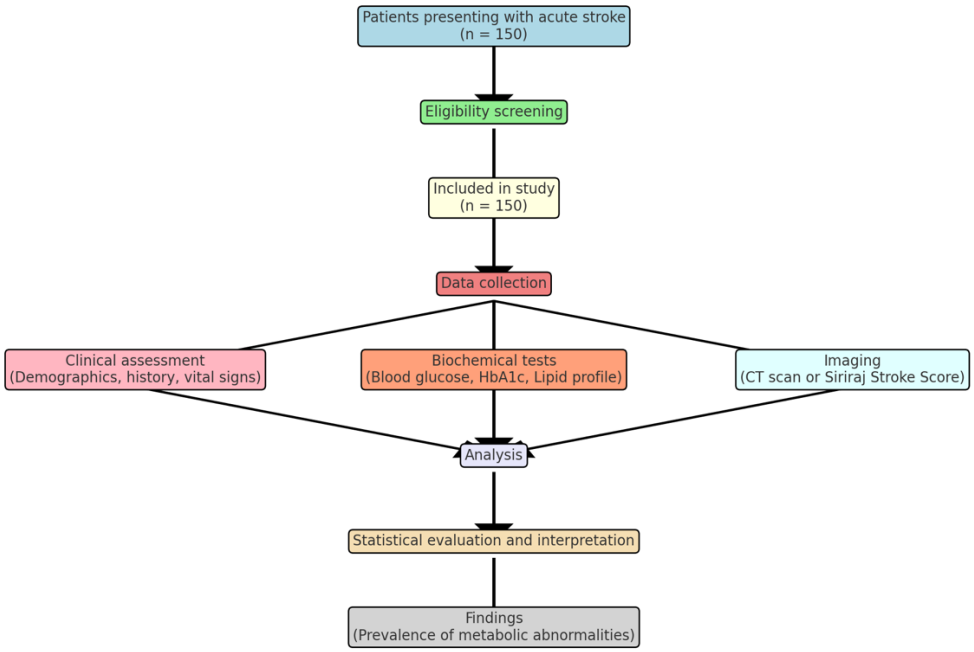
parameters, in patients presenting with acute stroke. The study included adult patients aged 18 years and older who were admitted within three days of an acute stroke episode, characterized by sudden neurological deficits consistent with ischemic or hemorrhagic stroke and persisting for more than 24 hours. Patients with neurological deficits due to trauma, neoplasm, or subdural/epidural hematoma, as well as those whose symptoms resolved within 24 hours or had pre-existing hepatic or renal diseases, malignancies, or were on lipid-lowering medications or steroids, were excluded flowchart 1.

Demographic and clinical data, including age, sex, body mass index, and history of diabetes mellitus, hypertension, smoking, and hyperlipidaemia, were documented for each patient. Upon admission, blood pressure and pulse rate were recorded. Biochemical assessments, performed within 72 hours of admission, included random blood glucose, glycosylated hemoglobin (HbA1c), and lipid profile parameters such as total cholesterol, LDL-C, HDL-C, and triglycerides. HbA1c levels ≥6.5% were used to diagnose diabetes mellitus, based on American Diabetes Association guidelines. Brain computed tomography (CT) scans were conducted for most patients to differentiate between ischemic and hemorrhagic strokes. In cases where CT scans were unavailable, the Siriraj Stroke Score was employed as a diagnostic tool .

Stroke was defined as rapidly developing clinical signs of focal or global cerebral dysfunction lasting more than 24 hours and attributable to vascular origin. Stress hyperglycemia was defined as random blood glucose >11.1 mmol/L in the presence of HbA1c <6.5%, while dyslipidemia included elevated LDL-C (≥100 mg/dL), reduced HDL-C (≤40 mg/dL in men and ≤50 mg/dL in women), elevated triglycerides (≥150 mg/dL), or total cholesterol (≥200 mg/dL). Undiagnosed diabetes was diagnosed when patients with random glucose >11.1 mmol/L also had an HbA1c ≥6.5%.

Statistical analyses were performed using appropriate statistical software. Descriptive statistics, including means and percentages, were used to summarize demographic and clinical characteristics. The Chi-square test was employed for categorical variables, while the Student's t-test was used for continuous variables, with a significance threshold of $p < 0.05$. Ethical approval for the study was obtained from the institutional ethics committee, and informed consent was secured from all participants or their legal representatives before their inclusion in the study.

Flowchart 1 illustrating the pathway from patient presentation to result interpretation.



Results

Table 1: General Characteristics of Patients

Parameter	Value
Total Patients	150
Mean Age (years)	63
Male (%)	55
Female (%)	45
Ischemic Stroke (%)	78
Hemorrhagic Stroke (%)	22

Table 1. Baseline characteristics of stroke patients, including demographic and stroke type distribution.

Table 2: Glycemic Status of Patients

Category	Number of Patients	Percentage (%)
Euglycemia	75	50.0
Known Diabetes	35	23.3
Undiagnosed Diabetes	20	13.3
Stress Hyperglycemia	20	13.3

Table 2. Distribution of glycemic statuses among stroke patients.

Table 3: Lipid Abnormalities in Patients

Parameter	Number of Patients	Percentage (%)
Elevated LDL-C	85	56.7
Low HDL-C	75	50.0
Elevated Total Cholesterol	45	30.0
Hypertriglyceridemia	35	23.3

Table 3. Prevalence of lipid abnormalities in the study population.

Figure 1 : Glycemic Status Distribution

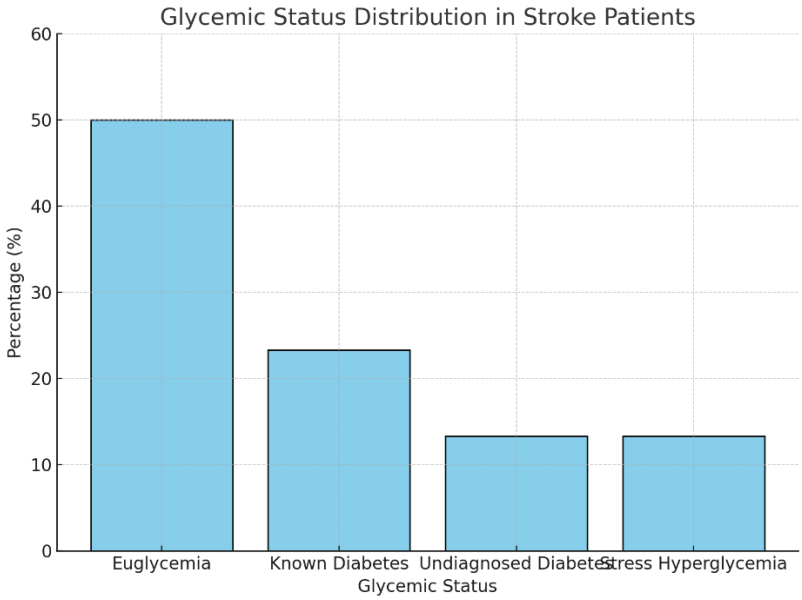


Figure 1. Glycemic status distribution among stroke patients, showing the proportions of euglycemia, known diabetes, undiagnosed diabetes, and stress hyperglycemia.

Figure 2 Distribution of Lipid Abnormalities in Stroke Patients

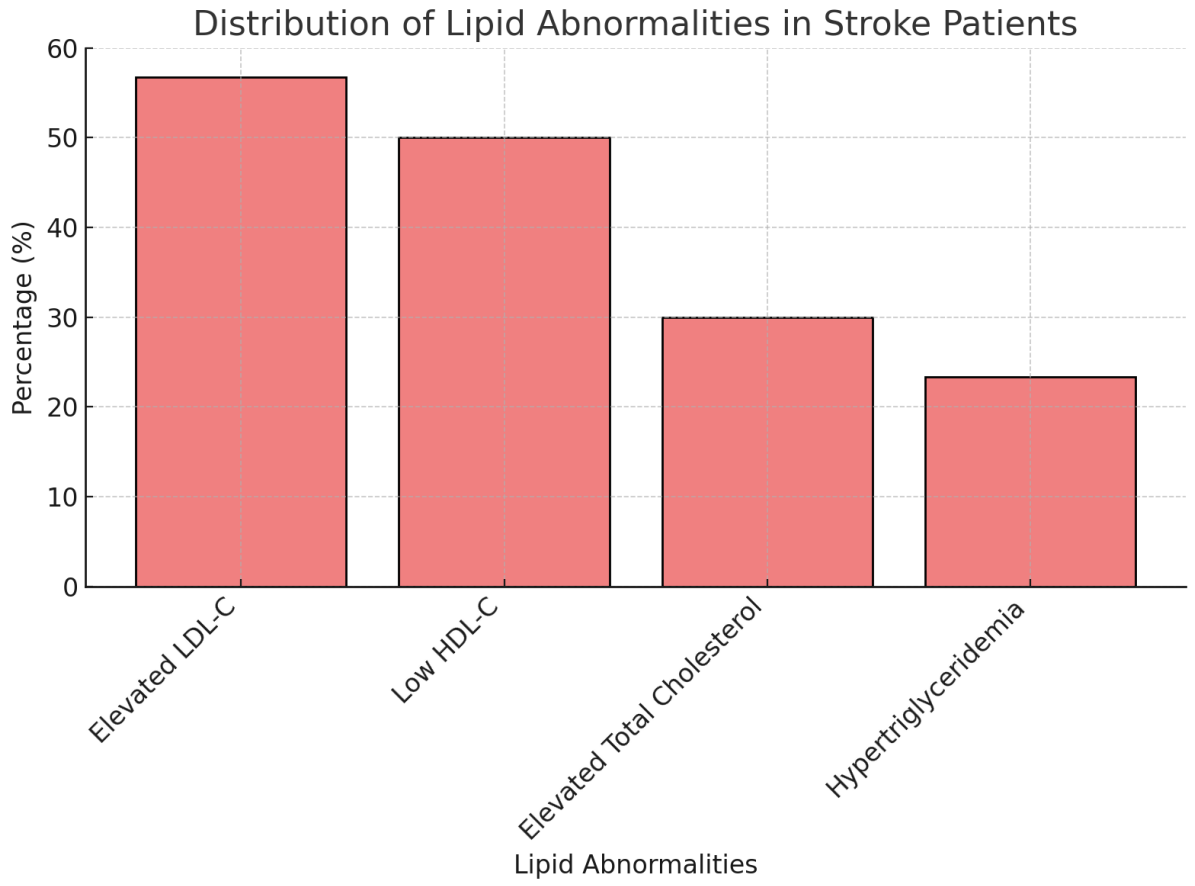


Figure 2. Distribution of lipid abnormalities, showing the prevalence of elevated LDL-C, low HDL-C, elevated total cholesterol, and hypertriglyceridemia.

The results highlight that 78% of patients had ischemic strokes (Table 1), with glycemic abnormalities being prominent. Approximately 50% of patients were euglycemic, while 23.3% had known diabetes, and 13.3% each were diagnosed with undiagnosed diabetes and stress hyperglycemia (Table 2). Lipid abnormalities, particularly elevated LDL-C (56.7%) and low HDL-C (50.0%), were prevalent among the population (Table 3). The distribution of glycemic status is further visualized in Figure 1, emphasizing the importance of glycemic management in stroke care.

Discussion

This study highlights the critical role of metabolic abnormalities in the context of acute stroke, emphasizing both glycemic and lipid disturbances as significant contributors to stroke risk and outcomes. The findings are consistent with existing literature but provide valuable regional insights.

Glycemic Abnormalities

The results demonstrate that glycemic abnormalities are prevalent among stroke patients, with approximately 50% presenting as euglycemic, and the remainder divided among known

diabetes (23.3%), undiagnosed diabetes (13.3%), and stress hyperglycemia (13.3%). Stress hyperglycemia, noted in both ischemic and hemorrhagic strokes, underscores the impact of acute physiological stress on glucose metabolism. The distribution aligns with previous studies that emphasize the role of stress-induced hyperglycemia as both a marker and a mediator of poor stroke outcomes. The presence of undiagnosed diabetes in 13.3% of patients highlights a missed opportunity for early intervention, further stressing the importance of routine metabolic screening in stroke patients(7,8).

Lipid Abnormalities

Lipid profile abnormalities were a prominent finding, with elevated LDL-C (56.7%) and low HDL-C (50.0%) being the most common. Elevated total cholesterol (30.0%) and hypertriglyceridemia (23.3%) were also noted, though less frequently. These findings are consistent with the established role of dyslipidemia as a major risk factor for ischemic stroke. The higher prevalence of lipid abnormalities in ischemic stroke compared to hemorrhagic stroke supports the hypothesis that dyslipidemia is more closely linked with atherosclerotic processes than with other stroke mechanisms. The observed lipid profile abnormalities further reinforce the need for aggressive lipid-lowering therapies in high-risk populations(9,10).

Clinical Implications

The detection of undiagnosed diabetes and dyslipidemia in this study underscores the critical role of opportunistic screening in improving stroke outcomes. HbA1c and lipid profile assessments should be standard practice in acute stroke care to identify high-risk patients and guide early therapeutic interventions. While HbA1c was used in this study, the potential utility of oral glucose tolerance tests (OGTT) as a more sensitive diagnostic tool for undiagnosed diabetes remains an area for further research. However, its practicality in the acute phase of stroke requires consideration(11).

The observed association between metabolic abnormalities and stroke highlights the need for a multidisciplinary approach to stroke management. This includes not only acute care but also long-term strategies for secondary prevention, focusing on glycemic and lipid control to reduce the risk of recurrent strokes and other vascular complications(12).

Limitations

The study's findings should be interpreted with caution, as not all patients underwent advanced imaging for stroke classification. Additionally, the use of HbA1c alone to diagnose undiagnosed diabetes may underestimate its prevalence compared to OGTT. Further studies with larger sample sizes and more comprehensive diagnostic criteria are needed to validate these findings.

Conclusion

This study reinforces the significance of metabolic abnormalities in stroke patients, particularly glycemic and lipid disturbances, and advocates for routine screening and aggressive management. By addressing these modifiable risk factors, clinicians can improve outcomes and reduce the burden of recurrent strokes. The findings emphasize the importance of

integrated care models that encompass both acute management and long-term prevention strategies.

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