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ORIGINAL RESEARCH

Comparative Profile of Ischemic and Hemorrhagic Stroke in Diabetic and Hypertensive Patients: A Prospective Observational Study from an Indian Emergency Department

Shubhi Shubhangi Bhatnagar[1], Nayan Sriramula[2], Gagan Srivastava[3]

[1]Department of Emergency Medicine, Government Medical College, Nashik, Maharashtra, India
[2]Department of Emergency Medicine and Trauma, Medicover Hospitals, Hyderabad, India
[3]Department of General Surgery, Muzaffarnagar Medical College, Muzaffarnagar, UP, India

ABSTRACT

Introduction: Hypertension and diabetes mellitus are major risk factors for stroke. This study compared stroke subtype, severity, and in-hospital outcomes between diabetic and hypertensive patients in an Indian emergency department.

Methods: A prospective observational study of 115 adults with radiologically confirmed stroke and documented diabetes or hypertension was conducted. Stroke type was determined by CT scan, and severity was assessed using the NIHSS.

Results: Ischemic stroke was predominant overall (74.8%). Hemorrhagic stroke was significantly more common in hypertensive patients, while ischemic stroke predominated among diabetics ($p < 0.01$). Stroke severity and in-hospital mortality did not differ significantly between groups.

Conclusion: Hypertension is more strongly associated with hemorrhagic stroke, whereas diabetes predominantly predisposes to ischemic stroke. However, stroke severity and short-term hospital outcomes were comparable between the two groups, emphasizing the need for effective risk-factor control in both conditions.

Keywords: Stroke; Ischemic stroke; Hemorrhagic stroke; Hypertension; Diabetes mellitus; NIHSS; Emergency medicine; In-hospital mortality; Cerebrovascular accident; Risk factors.

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INTRODUCTION

Stroke is a leading cause of mortality and long-term disability worldwide, with a disproportionately rising burden in low- and middle-income countries such as India.[1] Hypertension and diabetes mellitus are the two most significant modifiable risk factors for cerebrovascular accidents (CVA), collectively accounting for a substantial proportion of global stroke cases.[2] The epidemiological shift toward non-communicable diseases has intensified the clinical importance of understanding how these comorbidities influence stroke presentation and outcomes.

Hypertension contributes to stroke through large-artery atherosclerosis, small vessel disease, impaired cerebral autoregulation, and rupture of weakened intracerebral vessels, making it the strongest risk factor for both ischemic and haemorrhagic stroke.[2,3] In particular, chronic uncontrolled hypertension remains the predominant cause of spontaneous intracerebral haemorrhage.[3] Diabetes mellitus, on the other hand, accelerates atherosclerosis and promotes endothelial dysfunction, chronic inflammation, and platelet activation, thereby predisposing predominantly to ischemic stroke.[4-5] Epidemiological studies have demonstrated that individuals with diabetes have approximately a two-fold increased risk of ischemic stroke compared to non-diabetics.[5]

Indian population-based studies have reported high prevalence of hypertension among stroke patients and have also documented the growing contribution of diabetes to stroke burden, and other

Corresponding author
Dr. Nayan Sriramula * nayan.sriramula@gmail.com

debilitating illnesses.[6-12] However, despite extensive literature identifying both conditions as independent risk factors, comparative data evaluating differences in stroke subtype distribution, severity at presentation, and early outcomes between diabetic and hypertensive patients remain limited in the Indian emergency care context.

A direct comparison of stroke patterns in these two high-risk groups may provide clinically relevant insights into subtype predisposition and early hospital outcomes. Therefore, this prospective comparative observational study was undertaken to evaluate and contrast the type, severity, and in-hospital outcomes of stroke among patients with pre-existing diabetes versus hypertension.

MATERIALS AND METHODS

Study Design and Participants

This prospective comparative observational study was conducted in the Department of Emergency Medicine at Maharashtra Post Graduate Institute Of Medical Education and Research, MUHS, Nashik, over a period of two years. Ethical approval for the study was obtained from the Institutional Ethics Committee (IEC), Maharashtra Post Graduate Institute Of Medical Education and Research, MUHS, Nashik, under Ref. No. **MPGIMER Nashik/IEC/Outward No/33/2024.** The study was approved following full board review, and written informed consent was obtained from all participants prior to enrolment. The approval was valid for the entire duration of the study as per IEC guidelines. The study aimed to compare the incidence, type, severity, and short-term outcomes of cerebrovascular accidents (CVA) among patients with pre-existing diabetes mellitus and hypertension.

The calculated sample size was 115 patients, based on an expected incidence of CVA of 5%, a 95% confidence interval, and a 4% margin of error. Eligible patients were enrolled consecutively after obtaining informed written consent. Participants were categorized into two groups based on documented medical history: diabetic patients and hypertensive patients.

Inclusion and Exclusion Criteria

Inclusion Criteria

- Male and female patients aged >18-years
- Patients with a confirmed diagnosis of diabetes mellitus or hypertension
- Patients presenting with clinical features suggestive of acute stroke and subsequently diagnosed with cerebrovascular accident on neuroimaging

Exclusion Criteria

- Patients below 18-years of age
- Patients with stroke secondary to road traffic accidents
- Individuals without a confirmed history of diabetes or hypertension
- Patients with a single elevated blood pressure reading without prior diagnosis
- Patients with significant comorbid conditions that could confound clinical outcomes
- Patients intubated outside the hospital
- Patients with suspected aspiration confirmed on CT scan or chest imaging

Data Collection and Measurements

Patients presenting with acute focal neurological deficits fulfilling the Cincinnati Stroke Scale criteria (facial droop, arm drift, slurred speech) were evaluated in the emergency department. Initial stabilization was carried out following standard airway, breathing, and circulation (ABC) assessment protocols.

All patients underwent non-contrast computed tomography (CT) of the brain to confirm the diagnosis and classify stroke as ischemic or haemorrhagic. Stroke severity at admission was assessed using the National Institutes of Health Stroke Scale (NIHSS) and categorized as:

- Minor (0–4)
- Moderate (5–15)
- Moderate to severe (16–20)
- Severe (>21)

Demographic variables including age, gender, and residence (urban/rural) were recorded. Duration of hospital stay and in-hospital outcome (survived or deceased) were documented.

Statistical Analysis

Data were entered into a pre-designed study proforma and analysed using SPSS version 26.0. Qualitative variables were expressed as frequency and percentage. Associations between categorical variables were assessed using the Chi-square test. Quantitative variables were expressed as mean ± standard deviation. Between-group comparisons were performed using the unpaired t-test for normally distributed data and the Mann–Whitney U-test for non-normally distributed data. A *p-value* < 0.05 was considered statistically significant. Graphical representations were generated using Microsoft Excel 2021.

RESULTS

A total of 115 stroke patients were analyzed. Most patients were aged > 60-years (53.0%), followed by 41–60 years (44.3%), with only 2.6% aged ≤ 40-years. Gender distribution was nearly equal (50.4% males, 49.6% females). A majority (71.3%) were from urban areas. Hypertension (56.5%) was more prevalent than diabetes (43.5%) among co-morbidities. Ischemic stroke predominated (74.8%), while hemorrhagic stroke accounted for 25.2% of cases (Table 1). Overall, stroke occurrence was highest in elderly, urban-dwelling patients, with hypertension emerging as the most common associated risk factor.

Table 1: Distribution of study groups as per type of stroke: Ischemic stroke accounted for 74.8% of cases, while haemorrhagic stroke was seen in 25.2%.

Type of Stroke	N	%
Haemorrhagic	29	25.2%
Ischemic	86	74.8%
Total	115	100.0%

Among 115 stroke patients assessed using the NIHSS scale, moderate stroke was the most common severity category (44.3%). This was followed by moderate-to-severe stroke (33.9%), minor stroke (14.8%), and severe stroke (7.0%). Overall, nearly four-fifths of patients presented with moderate to moderately severe neurological deficits at admission. Only a small proportion had severe stroke (Table 2).

Table 2: Distribution of study groups as per severity of stroke (NIHSS Scale).

Severity of Stroke	N	%
Minor	17	14.8%
Moderate	51	44.3%
Moderate to Severe	39	33.9%
Severe	8	7.0%
Total	115	100.0%

Among 115 stroke patients, 93.0% survived while 7.0% died during hospitalization, indicating favorable in-hospital outcomes. Analysis of stroke severity by residence showed moderate stroke as the predominant category in both rural and urban groups. Although rural patients demonstrated a marginally higher proportion of moderate strokes and urban patients slightly more severe strokes, the association was not statistically significant (p=0.447). Similarly, mortality rates were comparable between rural (6.1%) and urban (7.3%) patients, with no significant difference (p=0.81). Overall, residence did not significantly influence stroke severity or in-hospital outcome.

Analysis of stroke type across co-morbidities revealed a statistically significant association ($p < 0.01$). Haemorrhagic stroke was more frequent among hypertensive patients (32.3%) compared to diabetics (16.0%), whereas ischemic stroke predominated in both groups but was higher in diabetics (84.0%) than hypertensives (67.7%) (Table 3). In contrast, no significant association was observed between stroke severity and co-morbidity ($p = 0.72$). Moderate stroke was the most common category in both diabetic (50.0%) and hypertensive (40.0%) patients. Overall, hypertension showed a stronger link with haemorrhagic stroke, while severity distribution remained comparable between groups.

Table 3: Association of type of stroke with co-morbidity.

Type of Stroke	Group		Total
	Diabetes	Hypertensive	
Haemorrhagic	8	21	29
	16.0%	32.3%	25.2%
Ischemic	42	44	86
	84.0%	67.7%	74.8%
Total	50	65	115
	100.0%	100.0%	100.0%
***p- value* <0.01**			

Analysis of stroke outcomes across co-morbidities (Table 4) showed that 90.0% of diabetic patients and 95.4% of hypertensive patients survived hospitalization. Mortality was higher among diabetics (10.0%) compared to hypertensives (4.6%). However, this difference was not statistically significant ($p = 0.29$). Overall survival was 93.0% in the cohort. These findings suggest that although diabetic patients demonstrated a numerically higher mortality rate, co-morbidity type did not significantly influence in-hospital outcomes. The absence of statistical significance indicates comparable short-term survival between diabetic and hypertensive stroke patients.

Table 4: Association of outcome of stroke with co-morbidity.

Outcome	Group		Total
	Diabetes	Hypertensive	
Survived	45	62	107
	90.0%	95.4%	93.0%
Deceased	5	3	8
	10.0%	4.6%	7.0%
Total	50	65	115
	100.0%	100.0%	100.0%
***p-value* – 0.29**			

DISCUSSION

The present prospective observational study demonstrated a statistically significant association between comorbidity type and stroke subtype, with haemorrhagic stroke more frequent among hypertensive patients and ischemic stroke predominating among diabetics. These findings (Table 5) align with extensive epidemiological evidence and established pathophysiological mechanisms.

Hypertension remains the most powerful modifiable risk factor for intracerebral haemorrhage. The Prospective Studies Collaboration showed a strong, continuous relationship between blood pressure and stroke mortality, particularly haemorrhagic stroke.[13] Furthermore, INTERSTROKE data confirmed that elevated blood pressure contributes the largest population-attributable risk for stroke globally.[14] Chronic hypertension induces vascular remodeling, lipohyalinosis, and microaneurysm formation in penetrating cerebral arteries, predisposing to vessel rupture and spontaneous intracerebral haemorrhage.[15] The higher proportion of haemorrhagic stroke among hypertensive patients in our cohort is therefore biologically plausible.

Conversely, diabetes mellitus predominantly increases the risk of ischemic stroke. The Emerging Risk Factors Collaboration meta-analysis demonstrated that diabetes approximately doubles the risk of ischemic stroke independent of other vascular risk factors.[16] Hyperglycemia promotes endothelial dysfunction, oxidative stress, and accelerated atherosclerosis, resulting in large-artery and small-vessel occlusive disease. Data from the UK Prospective Diabetes Study (UKPDS 35) further showed that worsening glycemic control is significantly associated with increased macrovascular complications, including stroke.[17] These mechanisms explain the predominance of ischemic stroke among diabetic patients in the present study. The differential profile observed between ischemic and hemorrhagic stroke in diabetic and hypertensive patients must be interpreted within the broader metabolic–vascular interplay characteristic of these chronic diseases. The coexistence of diabetes and hypertension

Table 5: Summary of the findings

- Hypertension was present in 56.5% of stroke patients; diabetes in 43.5%.
- Ischemic stroke was the predominant type (74.8%), while haemorrhagic stroke accounted for 25.2%.
- Stroke severity per NIHSS scores was categorized as moderate in 44.3%, moderate to severe in 33.9%, minor in 14.8%, and severe in 7.0%.
- Overall, 93% of patients survived and 7% died during hospital stay.
- Rural patients had a slightly higher proportion of severe stroke, but no statistically significant difference in severity or outcome by residence.
- Haemorrhagic stroke was significantly more frequent in hypertensive patients (32.3%) compared to diabetics (16.0%) ($p < 0.01$).
- Stroke severity was comparable between diabetic and hypertensive groups ($p = 0.72$).
- Mean hospital stay was slightly longer in hypertensives (6.62 days) vs. diabetics (6.08 days), though not statistically significant ($p = 0.34$).
- Mortality was higher in diabetics (10%) than hypertensives (4.6%), but this difference was not statistically significant ($p = 0.29$).

generates a pathophysiological "vicious cycle" involving endothelial dysfunction, oxidative stress, neurohormonal activation, and impaired autoregulation.[18] This environment predisposes not only to thrombotic ischemic events but also to vascular fragility and intracerebral hemorrhage, particularly in patients with long-standing uncontrolled hypertension.

From a vascular biology perspective, endothelial dysfunction, inflammatory activation, and plaque instability have been well described in acute coronary syndromes, where similar mechanisms drive myocardial infarction.[19] These processes are equally relevant in cerebrovascular disease, as small-vessel lipohyalinosis and large-vessel atherothrombosis share common inflammatory and lipid-mediated pathways. High-intensity statins, beyond lipid lowering, exert pleiotropic effects including plaque stabilization, anti-inflammatory modulation, improved nitric oxide bioavailability, and reduced thrombus propagation.[20] Such mechanisms underscore the importance of aggressive vascular risk modification in both ischemic and hemorrhagic stroke populations.

Emergency department data from myocardial infarction cohorts further highlight how metabolic and hemodynamic instability influence acute severity and outcomes. The association between systemic derangements and life-threatening electrical instability such as ventricular fibrillation[21] parallels the observation that stroke patients with compounded risk factors often present with higher neurological severity. Similarly, the use of structured triage tools such as the Emergency Severity Index (ESI) has demonstrated that severity categorization is influenced by systemic comorbidity burden and acute physiological compromise.[22] This reinforces the need for early, structured risk stratification in stroke patients presenting to emergency settings.

An additional dimension of emergency vulnerability is the unexpectedly high prevalence of underlying infectious comorbidities in cardiovascular emergency populations.[23] Chronic viral infections contribute to systemic inflammation and endothelial dysfunction, potentially amplifying cerebrovascular risk. In diabetic and hypertensive stroke patients, such additive inflammatory burdens may further modulate severity and outcomes.

Importantly, long-term blood pressure modulation remains central to preventing both ischemic and hemorrhagic stroke. Even modest reductions in systolic blood pressure have demonstrated meaningful vascular benefit and, in some cases, medication dose reduction.[24] This supports our findings that hypertension remains a dominant driver of hemorrhagic stroke in the studied cohort.

Finally, stroke severity at presentation carries profound implications for rehabilitation trajectory. Emerging AI-based tools in stroke rehabilitation highlight the role of early severity assessment in predicting motor recovery, personalizing therapy, and optimizing functional outcomes.[25] Thus, the differences observed between ischemic and hemorrhagic stroke profiles in our study extend beyond acute mortality and influence long-term disability burden.

Collectively, these findings reinforce that ischemic and hemorrhagic stroke in diabetic and hypertensive patients represent manifestations of a shared but variably expressed systemic vascular pathology. Early recognition, aggressive risk-factor control, structured emergency triage, and targeted long-term rehabilitation strategies are essential to improving outcomes in this high-risk population.

Interestingly, stroke severity at admission (based on NIHSS categories) did not significantly differ between diabetic and hypertensive groups. Similar findings have been reported in large stroke registries, where baseline severity correlated more strongly with lesion location, vascular territory involved, and time to presentation than with isolated risk factors.[26] This suggests that while comorbidities influence stroke subtype, early neurological deficit may depend on acute vascular dynamics and collateral circulation rather than the underlying metabolic condition alone.

Although mortality was numerically higher among diabetics in our cohort, the difference was not statistically significant. Prior meta-analytic evidence indicates that admission hyperglycemia—irrespective of diabetic status—is associated with increased mortality and poorer functional outcomes following ischemic stroke.[27] Admission hyperglycaemia may reflect broader metabolic dysfunction rather than an isolated stress response. Elevated uric acid–mediated oxidative stress and reduced osteocalcin-associated insulin resistance contribute to endothelial dysfunction, inflammation, and impaired glucose regulation. This integrated metabolic imbalance may amplify neuronal injury, explaining the association between higher admission glucose levels and increased stroke severity.[28,29] However, short-term in-hospital mortality may not fully reflect long-term disability, recurrence, and cardiovascular events, which are known to be higher among diabetics.

From an Indian public health perspective, the rising dual burden of hypertension and diabetes has been well documented by the

ICMR-INDIAB study, which reported high prevalence rates across both urban and rural populations.[30] The predominance of elderly and urban patients in our cohort reflects this epidemiological transition toward non-communicable diseases.

Overall, our findings reinforce that hypertension is more strongly linked to haemorrhagic stroke, whereas diabetes predisposes predominantly to ischemic stroke. Stroke severity and short-term survival, however, appear comparable between these high-risk groups, emphasizing the importance of comprehensive risk-factor control rather than disease-specific siloed management.

CONCLUSION

Hypertension is more strongly associated with hemorrhagic stroke, while diabetes mellitus predominantly predisposes to ischemic stroke. Despite differences in stroke subtype distribution, severity at presentation and short-term in-hospital outcomes were comparable between the two groups. These findings underscore the importance of comprehensive risk-factor control in both diabetic and hypertensive populations to reduce stroke burden and improve outcomes.

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