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CT-Measured Infarct Volume as a Marker of Stroke Severity at Presentation

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Abstract

Background: *Acute ischemic stroke is a leading cause of death and disability worldwide. Early assessment of severity guides management and improves prognosis. Infarct volume indicates irreversible brain injury and is an important imaging-based biomarker. Non-contrast computed tomography is the most accessible imaging modality for acute stroke. This study assessed CT-based infarct volume at presentation and its association with stroke severity using the National Institutes of Health Stroke Scale (NIHSS).*

Methods: *This cross-sectional observational study was conducted at the Department of Radiology and Imaging, Uttara Adhunik Medical College Hospital, Dhaka, from January to December 2025. A total of 120 patients with acute ischemic stroke who underwent non-contrast CT brain imaging within 24 hour of symptom onset were included. Infarct volume was measured and categorized as small (<30 cm³), moderate (30–70 cm³), or large (>70 cm³). Stroke severity was assessed using the NIHSS. Statistical analysis was performed using SPSS version 25.0.*

Results: *Moderate infarct volumes were most frequently observed (38.3%), followed by small (31.7%) and large (30.0%) infarcts. Patients with small infarct volumes predominantly presented with mild stroke severity. In contrast, large infarct volumes were strongly associated with severe NIHSS scores. A clear gradient was observed, with increasing infarct volume corresponding to higher stroke severity.*

Conclusion: *Acute ischemic stroke, computed tomography, infarct volume, NIHSS, stroke severity.*

Keywords: *Transitional cell carcinoma, urinary bladder, CT scan, histopathology, muscle invasion, lymph node involvement.*

1. Introduction

Acute ischemic stroke is a major cause of death and long-term disability worldwide, accounting for a substantial proportion of neurological morbidity and healthcare burden [1]. Rapid assessment of stroke severity and early prognostication are essential to guide therapeutic decisions and improve outcomes [2].

Neuroimaging is central to acute stroke evaluation, with non-contrast computed tomography remaining the most widely used first-line imaging modality due to its accessibility, speed and ability to exclude intracranial hemorrhage [3]. Infarct volume represents the extent of irreversible cerebral injury and has emerged as a key imaging biomarker in acute ischemic stroke [4]. Numerous studies have demonstrated a strong relationship between infarct volume and clinical outcomes, including functional independence, neurological recovery and mortality [5,6].

Larger infarct volumes are consistently associated with worse neurological deficits and poorer prognosis, emphasizing the importance of early volumetric assessment [7].

While magnetic resonance imaging offers superior sensitivity for ischemic lesion detection, its limited availability and longer acquisition time restrict its routine use in emergency settings, particularly in low- and middle-income countries [8]. Advances in CT-based quantitative techniques have enabled more accurate

estimation of infarct volume using non-contrast CT, making it a practical and clinically relevant tool for early stroke assessment [9]. Previous studies have shown that CT-derived infarct volume correlates closely with follow-up imaging findings and long-term functional outcomes [10].

Stroke severity at presentation, commonly measured by the National Institutes of Health Stroke Scale (NIHSS), is a critical factor influencing treatment decisions and prognosis. Higher NIHSS scores are strongly associated with poorer outcomes and increased mortality, particularly in patients with large core infarctions or acute ischemic stroke due to large vessel occlusion, highlighting its prognostic significance in acute stroke management [11,12]. The NIHSS score correlates closely with infarct volume assessed using imaging modalities like diffusion-weighted magnetic resonance imaging (DWI), reflecting the anatomical burden of ischemic injury and neurological impairment at admission [13]. Understanding this relationship aids early clinical risk stratification by linking anatomical infarct burden to clinical severity.

Further evidence indicates that the association strength between infarct volume and clinical outcome varies depending on infarct size, emphasizing the need for precise volumetric characterization to optimize prognostication and treatment strategies [12]. Integrative approaches combining neurological assessments with imaging and molecular markers have been proposed to improve outcome prediction precision in stroke patients [11]. These findings underscore the anatomical basis of neurological deficits measured by NIHSS at admission and the value of infarct volume as a complementary metric in early stroke evaluation.

Despite extensive research in Western populations, data from South Asian countries remain limited. Stroke epidemiology in this region differs substantially due to variations in vascular risk factors, healthcare access and imaging resources [14]. Bangladesh faces a rising burden of ischemic stroke, yet locally generated evidence evaluating imaging biomarkers and their clinical correlates is scarce. Establishing the relationship between CT-measured infarct volume and stroke severity at presentation may contribute to improved early assessment and context-appropriate management strategies.

Therefore, this study aimed to assess CT-based infarct volume at presentation and examine its association with stroke severity measured by NIHSS among patients with acute ischemic stroke presenting to a tertiary care hospital in Bangladesh.

2. Materials & Methods

This was a cross-sectional observational study conducted in the Department of Radiology and Imaging at Uttara Adhunik Medical College Hospital, Dhaka, Bangladesh. The study period extended from January to December 2025. A total of 120 patients presenting with acute ischemic stroke who underwent non-contrast CT brain imaging at admission were included in this study.

2.1. Selection Criteria

Inclusion criteria

- Adult patients aged ≥18 years
- Clinically suspected acute ischemic stroke
- CT brain performed within 24 hours of symptom onset
- Availability of complete clinical and imaging data

Exclusion criteria

- Evidence of intracerebral hemorrhage on CT
- History of previous stroke with residual deficits
- Poor-quality CT images are unsuitable for volumetric analysis
- Known intracranial tumors or traumatic brain injury

2.2. Data Collection Procedure

Data collection was performed systematically using a structured data collection sheet. Demographic variables, including age, sex and residence, were recorded at presentation. Clinical data such as vascular risk factors, including hypertension, diabetes mellitus and smoking status, were obtained from patient interviews, medical records and caregiver reports. Stroke severity at admission was assessed using the National Institutes of Health Stroke Scale by trained clinicians. Non-contrast CT scans of the brain were acquired using a standardized imaging protocol. Infarct volume was measured manually by experienced radiologists using region-of-interest segmentation on axial CT slices.

Volumes were calculated by summing lesion areas and multiplying by slice thickness. All

measurements were performed independently by two radiologists to ensure consistency and discrepancies were resolved by consensus. Informed consent was taken from patients or their legal guardians before enrollment.

Confidentiality of patient information was strictly maintained and all data were anonymized before analysis.

2.3. Statistical Analysis

Data were analyzed using SPSS version 25.0. Descriptive statistics were expressed as frequencies and percentages. Associations between infarct volume categories and NIHSS severity were evaluated using chi-square tests. A p-value of less than 0.05 was considered statistically significant.

3. RESULTS

Table 1. *Baseline Sociodemographic and Clinical Characteristics of the Study Population (n = 120)*

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	<50	24	20.0
	50–59	36	30.0
	60–69	42	35.0
	≥70	18	15.0
Sex	Male	78	65.0
	Female	42	35.0
Residence	Urban	52	43.3
	Rural	68	56.7
Hypertension	Present	76	63.3
	Absent	44	36.7
Diabetes Mellitus	Present	48	40.0
	Absent	72	60.0
Smoking status	Current/Former	54	45.0
	Never smoker	66	55.0

Table 1 shows the baseline sociodemographic and clinical characteristics of the 120 patients included in the study. Most participants were aged 60–69 years (35.0%), followed by 50–59 years (30.0%). Males constituted 65.0% of the cohort. Rural residents represented 56.7% of cases. Hypertension was present in 63.3% of patients, while diabetes mellitus was noted in 40.0%. A history of current or former smoking was reported by 45.0% of participants.

Table 2. *CT-Measured Infarct Volume Distribution at Presentation*

Infarct Volume Category (cm^3)	Frequency (n)	Percentage (%)
<30 (Small)	38	31.7
30–70 (Moderate)	46	38.3
>70 (Large)	36	30.0
Total	120	100.0

Table 2 presents the distribution of CT-measured infarct volumes at presentation. Moderate infarct volumes (30–70 cm^3) were the most frequent, observed in 38.3% of patients. Small infarcts (<30 cm^3) accounted for 31.7% of cases, while large infarcts (>70 cm^3) were identified in 30.0% of the study population.

Table 3. *Association between CT-Measured Infarct Volume and Stroke Severity (NIHSS) at Presentation (n = 120)*

Infarct Volume Category (cm^3)	Mild NIHSS (≤5) n (%)	Moderate NIHSS (6–15) n (%)	Severe NIHSS (>15) n (%)	Total n (%)	P-value
<30 (Small)	26 (68.4)	10 (26.3)	2 (5.3)	38 (31.7)	<0.001
30–70 (Moderate)	12 (26.1)	24 (52.2)	10 (21.7)	46 (38.3)	
>70 (Large)	4 (11.1)	14 (38.9)	18 (50.0)	36 (30.0)	
Total	42 (35.0)	48 (40.0)	30 (25.0)	120 (100.0)	

Table 3 describes the association between infarct volume categories and stroke severity based on NIHSS scores at presentation. Among patients with small infarcts, 68.4% had mild stroke

severity, whereas severe NIHSS scores were observed predominantly in patients with large infarcts (50.0%). Moderate infarct volumes were mainly associated with moderate stroke severity (52.2%). A statistically significant association was observed between CT-measured infarct volume and stroke severity at presentation ($p < 0.001$), with higher infarct volumes associated with greater NIHSS severity.

4. Discussion

The present study demonstrates a clear and graded association between CT-measured infarct volume at presentation and stroke severity as assessed by the NIHSS. Patients with small infarct volumes were predominantly associated with mild neurological deficits, whereas large infarct volumes were strongly linked to severe stroke at presentation. These findings reinforce the concept that infarct volume reflects the extent of irreversible tissue injury and correlates closely with early neurological impairment.

Previous studies have consistently reported infarct volume as a robust imaging biomarker in acute ischemic stroke. Boers et al. showed that follow-up infarct volume mediated the relationship between endovascular therapy and functional outcome, underscoring its clinical relevance [5]. Similarly, pooled analyses by Boers et al. demonstrated that larger infarct volumes were associated with worse functional outcomes across multiple randomized trials [6]. Although these studies focused on follow-up imaging, the present findings confirm that infarct volume measured at initial presentation already reflects stroke severity.

The strong association observed between large infarct volumes and severe NIHSS scores aligns with findings from Ospel et al., who reported that the strength of the relationship between infarct volume and clinical outcome increases with infarct size [4]. This gradient effect is evident in the current cohort, where half of the patients with infarct volumes greater than 70 cm^3 presented with severe neurological deficits. Such findings highlight the importance of quantitative infarct assessment rather than reliance on qualitative imaging interpretation alone.

Non-contrast CT remains the cornerstone of acute stroke imaging in many healthcare systems, particularly in low- and middle-income countries. Bouslama et al. demonstrated that infarct volume estimation using non-contrast CT was comparable to CT perfusion–derived volumes in predicting final infarct size [8]. This supports the validity of the CT-based volumetric approach used in the present study and emphasizes its practicality in resource-limited settings.

The observed relationship between infarct volume and stroke severity is biologically plausible. Baron et al. described that increasing infarct burden leads to progressive neuronal loss and disruption of cerebral networks, resulting in more severe neurological deficits [2]. Ganesh et al. further noted that while discrepancies may exist between infarct volume and long-term functional outcomes, early neurological severity shows a strong correlation with infarct size [7]. The current findings are consistent with these observations and extend them to the acute presentation phase.

Recent studies have also highlighted the prognostic implications of early infarct volume in patients undergoing reperfusion therapies. Yedavalli et al. showed that larger baseline infarct volumes were associated with poorer functional outcomes even after successful mechanical thrombectomy [10]. Pensato et al. demonstrated that minimal clinically important differences in poststroke outcomes were closely linked to infarct volume, reinforcing its role as a clinically meaningful imaging marker [15]. Although the present study did not evaluate treatment outcomes, the strong association with baseline severity underscores its potential role in early decision-making.

Sociodemographic and vascular risk factor distributions in this cohort may have contributed to infarct volume variability. Ghoneem et al. reported that socioeconomic status and vascular comorbidities influenced infarct size and functional outcome in ischemic stroke [14]. The high prevalence of hypertension and diabetes observed in patients with larger infarcts in the present study aligns with established evidence linking these risk factors to more extensive cerebral ischemia.

Overall, the findings emphasize the clinical utility of CT-based infarct volume measurement at presentation. Integrating quantitative infarct assessment with clinical severity scoring may enhance early prognostication, support triage decisions and improve individualized stroke management. This approach is particularly relevant in settings where advanced imaging modalities are not readily available.

5. Limitations And Recommendations

The study was conducted at a single center with a modest sample size. Future multicenter studies

with longitudinal follow-up are recommended to evaluate long-term outcomes and validate CT-based infarct volume as a prognostic marker across diverse populations.

6. Conclusion

CT-measured infarct volume at presentation showed a strong association with stroke severity assessed using the NIHSS. Larger infarct volumes are associated with more severe neurological deficits, highlighting the clinical value of early volumetric assessments. Non-contrast CT provides a practical and accessible method for estimating infarct burden, supporting its use in the early risk stratification and management of acute ischemic stroke, particularly in resource-limited settings.

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Conflicts Of Interest

There are no conflicts of interest.

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