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Original Research Article

Clinical Predictors of Large Vessel Occlusion and Diagnostic Accuracy of Non-Contrast CT in Acute Ischemic Stroke: A Cross-Sectional Study

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Abstract

Introduction: Large vessel occlusion (LVO) is a major determinant of morbidity and mortality in acute ischemic stroke (AIS), requiring rapid identification for timely reperfusion therapy. While computed tomography angiography (CTA) is the reference standard for detecting LVO, non-contrast computed tomography (NCCT) remains the most widely accessible imaging modality in many healthcare settings. This study evaluated clinical predictors of LVO and assessed the diagnostic performance of NCCT against CTA-confirmed occlusion.

Methods: A hospital-based cross-sectional study was conducted among 72 consecutive adults presenting with suspected AIS who underwent both NCCT and CTA. Demographic characteristics, clinical presentations, vascular risk factors, and imaging findings were analyzed. Multivariable logistic regression was used to identify independent predictors of LVO. Diagnostic accuracy parameters of NCCT were calculated using CTA as the reference standard.

Results: CTA confirmed LVO in 43 patients (59.7%). The middle cerebral artery was the most commonly affected vessel (69.8%). Hemiparesis showed a significant association with LVO (OR 2.89, 95% CI: 1.08–7.73; p=0.034) and remained the only independent predictor on multivariable analysis (adjusted OR 3.06, 95% CI: 1.09–8.61; p=0.034). NCCT demonstrated a sensitivity of 88.4%, specificity of 72.4%, positive predictive value of 82.6%, negative predictive value of 80.8%, and overall diagnostic accuracy of 81.9% for detecting CTA-confirmed LVO.

Conclusion: LVO was common among patients presenting with suspected AIS. Hemiparesis independently predicted the presence of LVO, while NCCT exhibited high sensitivity and satisfactory diagnostic accuracy. Integration of clinical assessment with NCCT findings may facilitate early triage and prompt referral for advanced stroke management, particularly in resource-limited settings.

Keywords: Acute ischemic stroke, Large vessel occlusion, Computed tomography angiography, Non-contrast computed tomography, Hemiparesis, Stroke imaging, Endovascular thrombectomy, Diagnostic accuracy.

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Introduction

Acute ischemic stroke (AIS) remains a leading cause of mortality and long-term disability worldwide, accounting for a substantial proportion of the global neurological disease burden [1]. Despite advances in preventive strategies and acute stroke care, timely diagnosis and treatment continue to be the most important determinants of neurological outcome. Among patients with AIS, large vessel occlusion (LVO) represents a particularly severe subtype associated with extensive cerebral infarction, higher rates of functional dependence, and increased mortality when reperfusion is delayed [2,3]. The advent of endovascular thrombectomy has transformed the management of LVO, demonstrating significant clinical benefit across multiple randomized controlled trials and establishing rapid vessel imaging as a cornerstone of contemporary stroke pathways [4,5].

Computed tomography angiography (CTA) is currently regarded as the reference imaging modality for the detection and characterization of intracranial arterial occlusions in the acute setting [6]. However, access to CTA may be limited in resource-constrained environments, smaller healthcare facilities, or during off-hours. Consequently, non-contrast computed tomography (NCCT) remains the most widely available first-line imaging investigation for patients presenting with suspected stroke. While NCCT is primarily used to exclude intracranial hemorrhage, several early ischemic signs, including loss of gray–white differentiation, insular ribbon changes, and the hyperdense middle cerebral artery sign, may provide indirect evidence of underlying LVO [7,8]. Determining the diagnostic utility of these findings is clinically relevant, particularly in settings where rapid triage decisions are required.

In addition to imaging, clinical presentation may offer important clues to the presence of LVO. Neurological deficits such as hemiparesis, aphasia, facial weakness, gaze deviation, and altered consciousness have been associated with proximal arterial occlusion and have formed the basis of several prehospital stroke severity scales [9,10]. Nevertheless, the predictive value of individual symptoms and vascular risk factors varies across populations, and data from real-world hospital cohorts remain limited.

Given the critical importance of early LVO identification for timely reperfusion therapy, further evidence is needed regarding the clinical and radiological factors associated with vessel occlusion. Therefore, the present study aimed to evaluate the clinical predictors, risk factor profile, and imaging characteristics of large vessel occlusion among patients presenting with acute ischemic stroke symptoms, and to assess the diagnostic performance of non-contrast CT findings against CTA-confirmed occlusion.

Materials and Methods

Study Design and Setting

This hospital-based observational analytical study was conducted in the Department of Radiodiagnosis in collaboration with the Department of Neurology at a tertiary care teaching hospital in North India. The study included consecutive adult patients presenting with symptoms suggestive of acute ischemic stroke who underwent emergency neuroimaging as part of routine clinical evaluation. The study was designed to assess the clinical and radiological predictors of large vessel occlusion (LVO) and to evaluate the diagnostic performance of non-contrast computed tomography (NCCT) against computed tomography angiography (CTA) findings.

Study Population

Patients aged ≥18 years presenting with acute focal neurological deficits suggestive of ischemic stroke and referred for NCCT followed by CTA of the cerebral circulation were considered eligible for inclusion. Consecutive patients fulfilling the eligibility criteria during the study period were enrolled to minimize selection bias.

Inclusion Criteria

1. Age ≥18 years.
2. Clinical suspicion of acute ischemic stroke based on neurological assessment.
3. Availability of both NCCT and CTA imaging performed during the same acute presentation.
4. Availability of complete clinical and imaging records.

Exclusion Criteria

1. Intracranial hemorrhage detected on initial imaging.
2. History of major cranial surgery causing significant imaging distortion.
3. Poor-quality or incomplete imaging studies precluding reliable interpretation.
4. Patients with incomplete demographic, clinical, or radiological data.

Clinical Assessment

Baseline demographic characteristics, including age and sex, were recorded at presentation. Detailed clinical information was obtained from emergency department records, neurological examination findings, and inpatient case files. Presenting symptoms including hemiparesis, speech disturbance, facial deviation, dizziness, gait imbalance, altered sensorium, and aphasia were documented. Vascular risk factors such as hypertension, diabetes mellitus, smoking history, dyslipidemia, cardiac disease, and previous stroke or transient ischemic attack were also recorded using documented medical history and treatment records [11,12].

The time interval between symptom onset and hospital presentation was categorized as ≤6 hours, 6–12 hours, and 12–24 hours. In patients with uncertain symptom onset, timing was classified according to the documented clinical record.

Imaging Protocol

All patients initially underwent NCCT of the brain to exclude intracranial hemorrhage and identify early ischemic changes. NCCT images were evaluated for features suggestive of acute ischemia, including loss of gray–white matter differentiation, sulcal effacement, insular ribbon sign, and hyperdense intracranial artery signs [13,14]. Subsequently, CTA of the intracranial and extracranial cerebral circulation was performed according to institutional stroke imaging protocols. CTA findings served as the reference standard for identification of large vessel occlusion. Occlusions involving the intracranial internal carotid artery (ICA), middle cerebral artery (M1/M2 segments), posterior cerebral artery (PCA), vertebral artery, or basilar artery were classified as LVO based on established neurovascular imaging criteria [15,16].

Outcome Measures

The primary outcome was the presence of CTA-confirmed large vessel occlusion.

Secondary outcomes included:

1. Distribution of occlusion sites.
2. Association between presenting clinical features and LVO.
3. Association between vascular risk factors and LVO.
4. Diagnostic accuracy of NCCT findings for predicting CTA-confirmed occlusion.
5. Relationship of age, sex, and time-to-presentation with occlusion characteristics.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) or median with range, as appropriate. Categorical variables were summarized as frequencies and percentages.

Comparisons between groups were performed using the independent-samples t-test or one-way analysis of variance (ANOVA) for normally distributed continuous variables. Non-parametric data were analysed using the Mann–Whitney U test or Kruskal–Wallis test. Associations between categorical variables were assessed using the Chi-square test or Fisher's exact test whenever appropriate.

Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to evaluate the relationship between clinical variables and LVO. Variables demonstrating clinical relevance or statistical association in univariate analysis were entered into a multivariable logistic regression model to identify independent predictors of large vessel occlusion. Model performance was assessed using the coefficient of determination (Nagelkerke R^2). Diagnostic accuracy measures, including sensitivity and specificity of NCCT findings relative to CTA-confirmed occlusion, were calculated using standard contingency table analysis. A two-tailed p-value <0.05 was considered statistically significant [17].

Ethical Considerations

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and its subsequent amendments. Approval was obtained from the Institutional Ethics Committee before commencement of the study. Patient confidentiality was maintained throughout data collection and analysis, and all data were anonymized prior to statistical evaluation [18].

Results

A total of 72 consecutive patients presenting with suspected acute ischemic stroke were included in the analysis. The mean age of the study population was 62.4 ± 15.8 years (range: 28–88 years), and 38 (52.8%) were male. CTA confirmed large vessel occlusion (LVO) in 43 patients (59.7%), whereas 22 patients (30.6%) had acute ischemic stroke without LVO and 7 (9.7%) showed no major intracranial abnormality.

Table 1. Baseline demographic characteristics, presentation profile, and vascular risk factors of the study population (N=72)

Variable	n (%)
Male sex	38 (52.8)
Female sex	34 (47.2)
Mean age, years (SD)	62.4 ± 15.8
Presentation ≤6 h	28 (38.9)
Presentation 6–12 h	18 (25.0)
Presentation 12–24 h	13 (18.1)
Unspecified onset	13 (18.1)
Hemiparesis	52 (72.2)
Speech difficulty	44 (61.1)
Facial droop	29 (40.3)
Dizziness/vertigo	24 (33.3)
Gait imbalance/ataxia	15 (20.8)
Altered sensorium	12 (16.7)
Aphasia	12 (16.7)
Hypertension	48 (66.7)
Diabetes mellitus	28 (38.9)
Smoking history	15 (20.8)
Dyslipidaemia	14 (19.4)
Cardiac disease	13 (18.1)
Previous stroke/TIA	10 (13.9)

The study cohort predominantly consisted of older adults with a high burden of vascular risk factors **(table 1)**. Hypertension was the most frequent comorbidity, affecting two-thirds of participants, followed by diabetes mellitus. Hemiparesis and speech disturbance represented the dominant

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presenting manifestations. More than one-third of patients presented within six hours of symptom onset, placing them within the conventional reperfusion treatment window.

Table 2. Stroke subtype distribution and anatomical characteristics of CTA-confirmed large vessel occlusion

Variable	n (%)
Acute ischemic stroke with LVO	43 (59.7)
Acute ischemic stroke without LVO	22 (30.6)
No major intracranial abnormality	7 (9.7)
Occlusion site among LVO patients (n=43)	
MCA (M1/M2)	30 (69.8)
ICA (± MCA)	19 (44.2)
PCA/posterior circulation	9 (20.9)
Vertebrobasilar	5 (11.6)
Multiple vessel occlusion	5 (11.6)

LVO was identified in nearly 60% of patients undergoing CTA **(table 2)**. The middle cerebral artery represented the most frequently involved vascular territory, followed by the internal carotid artery. Posterior circulation occlusions constituted a smaller but clinically relevant proportion of cases. Multiple vascular territory involvement was observed in a subset of patients, indicating complex thromboembolic disease.

Table 3. Clinical and vascular risk factor associations with large vessel occlusion

Variable	LVO rate (%)	Odds Ratio	95% CI	p-value
Hemiparesis	69.2	2.89	1.08–7.73	0.034*
Speech difficulty	68.2	2.14	0.87–5.26	0.096
Facial droop	69.0	1.98	0.76–5.14	0.162
Dizziness/vertigo	45.8	0.42	0.16–1.09	0.074
Altered sensorium	83.3	3.75	0.77–18.27	0.099
Aphasia	83.3	3.22	0.66–15.64	0.146
Hypertension	66.7	2.15	0.81–5.69	0.121
Diabetes mellitus	67.9	1.75	0.66–4.63	0.260
Cardiac disease	84.6	3.99	0.84–19.02	0.081
Smoking history	66.7	1.21	0.38–3.84	0.743
Previous stroke/TIA	50.0	0.52	0.14–1.98	0.338
*Statistically significant				

Among all clinical variables evaluated, hemiparesis demonstrated a significant association with LVO, conferring nearly threefold higher odds of occlusion **(table 3)**. Cardiac disease showed the strongest numerical association among vascular risk factors, although statistical significance was not reached. Symptoms typically associated with posterior circulation involvement, particularly dizziness, showed an inverse relationship with LVO. These findings suggest that clinical examination remains valuable for early triage and prioritization of vascular imaging.

After adjustment for demographic characteristics, vascular risk factors, and timing of presentation, hemiparesis remained the only independent predictor of LVO **(table 4).** Patients presenting with unilateral motor weakness had approximately three times greater odds of harboring a major intracranial arterial occlusion. Although cardiac disease demonstrated a strong adjusted effect size, the association did not achieve statistical significance, likely reflecting the modest sample size.

Table 4. Multivariable logistic regression analysis for predictors of large vessel occlusion

Variable	Adjusted OR	95% CI	p-value
Age (per 10-year increase)	1.23	0.92 – 1.65	0.162
Male sex	0.92	0.35 – 2.43	0.871
Hemiparesis	3.06	1.09 – 8.61	0.034 *
Cardiac disease	4.26	0.87 – 20.85	0.074
Hypertension	1.86	0.66 – 5.24	0.241
Presentation ≤6 h	1.62	0.62 – 4.21	0.324
Model $R^2 \approx 18.7\%$, *Statistically significant			

Table 5. Diagnostic performance of NCCT for detection of CTA-confirmed large vessel occlusion

NCCT finding	CTA LVO Present	CTA LVO Absent	Total
Positive NCCT	38	8	46
Negative NCCT	5	21	26
Total	43	29	72
Sensitivity: 88.4% **Specificity:** 72.4% **Positive Predictive Value:** 82.6% **Negative Predictive Value:** 80.8% **Diagnostic Accuracy:** 81.9% **p = 0.607**			

NCCT demonstrated high sensitivity for identifying patients with CTA-confirmed LVO, correctly detecting nearly nine out of ten occlusions **(table 5)**. Specificity was moderate, indicating the presence of some false-positive interpretations. Nevertheless, the overall diagnostic accuracy exceeded 80%, supporting the role of NCCT as a valuable initial screening tool in acute stroke pathways, particularly in settings where immediate vascular imaging may not be universally available.

Discussion

Early identification of large vessel occlusion (LVO) remains one of the most critical challenges in contemporary stroke care because timely reperfusion therapy is strongly associated with improved neurological outcomes and reduced disability [2,4,5]. In the present study, CTA-confirmed LVO was detected in nearly 60% of patients presenting with suspected acute ischemic stroke. This relatively high proportion is consistent with the referral pattern expected in a tertiary-care centre with advanced neuroimaging facilities and reflects the increasing emphasis on rapid identification of patients eligible for endovascular intervention. Our findings demonstrate that specific clinical features, particularly hemiparesis, retain substantial predictive value for LVO, while NCCT continues to provide meaningful diagnostic information in the acute setting.

The demographic profile of the study population is comparable to contemporary stroke cohorts reported from both developed and developing regions. The mean age of 62.4 years and the predominance of traditional vascular risk factors such as hypertension and diabetes mellitus are consistent with the epidemiological transition observed across South Asian populations [12,19]. Although patients with

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LVO tended to be older than those without LVO, the difference did not achieve statistical significance. Similar observations have been reported in multicentre stroke registries where age influences overall stroke risk but may not independently determine the presence of proximal arterial occlusion after adjustment for other vascular factors [20].

A notable finding of the present study was the predominance of middle cerebral artery (MCA) occlusion, followed by involvement of the internal carotid artery. This pattern aligns with established cerebrovascular anatomy and previous angiographic studies demonstrating that the anterior circulation accounts for the majority of clinically significant LVOs [21,22]. The high frequency of MCA involvement also explains the predominance of motor deficits and language disturbances observed in the cohort. Posterior circulation occlusions represented a smaller proportion of cases, yet their presence remains clinically important because delayed recognition continues to contribute to adverse outcomes despite advances in stroke systems of care [23].

Among all presenting symptoms evaluated, hemiparesis emerged as the only independent predictor of LVO after multivariable adjustment. Patients presenting with unilateral motor weakness exhibited approximately threefold higher odds of harbouring a major intracranial arterial occlusion. This finding is biologically plausible because large anterior circulation infarctions frequently involve the corticospinal tract and motor cortex, producing prominent motor deficits. The result is also consistent with studies validating stroke severity scales such as the Cincinnati Prehospital Stroke Severity Scale and Rapid Arterial Occlusion Evaluation scale, both of which assign substantial weight to motor dysfunction when predicting LVO [10,24]. While speech disturbance, aphasia, and altered sensorium demonstrated positive associations with LVO, these relationships did not reach statistical significance, likely owing to limited sample size and the heterogeneity of stroke syndromes.

Cardiac disease demonstrated the strongest association among vascular risk factors, with nearly fourfold increased odds of LVO in univariate analysis and more than fourfold increased odds after adjustment. Although statistical significance was not achieved, the magnitude of effect is clinically meaningful. Cardioembolic stroke is a well-recognized mechanism underlying proximal arterial occlusions, particularly in patients with atrial fibrillation and structural heart disease [25,26]. The absence of statistical significance in our study is likely attributable to the relatively small number of patients with documented cardiac pathology rather than the absence of a true association. Larger multicentre investigations may further clarify this relationship within the Indian population.

An important observation was the lack of significant association between time-to-presentation and the presence of LVO. Patients with LVO tended to present earlier than those without LVO, but the difference was not statistically significant. Previous studies have suggested that severe neurological deficits often prompt earlier healthcare-seeking behaviour, whereas milder or posterior circulation symptoms may delay presentation [27]. The present findings indicate that although symptom severity may influence presentation patterns, delays in recognition and access to specialized care remain common across stroke subtypes. This observation underscores the continuing need for public awareness initiatives and streamlined stroke referral pathways.

The diagnostic performance analysis demonstrated that NCCT identified CTA-confirmed LVO with a sensitivity of 88.4% and specificity of 72.4%. These findings reinforce the continuing relevance of NCCT in acute stroke evaluation. Although CTA remains the preferred modality for direct visualization of intracranial occlusion, NCCT possesses several practical advantages including widespread availability, rapid acquisition, lower cost, and applicability in emergency settings where vascular imaging may not be immediately accessible [6,16]. Previous investigations have shown that hyperdense artery signs and early ischemic changes can serve as useful surrogate markers of vessel occlusion, particularly when interpreted by experienced readers [8,28]. The high sensitivity observed in our study suggests that NCCT may function as an effective initial screening tool, facilitating early triage and prioritization of patients for advanced imaging and reperfusion therapies.

From a broader clinical perspective, our findings support a combined clinical-radiological approach to stroke triage. Reliance on clinical examination alone may overlook atypical presentations, whereas exclusive dependence on advanced imaging may not be feasible in all healthcare environments. The observation that hemiparesis independently predicts LVO, together with the strong diagnostic performance of NCCT, suggests that integrating bedside neurological assessment with readily available imaging could improve patient selection for urgent CTA and thrombectomy evaluation, particularly in resource-limited settings. This approach may be especially relevant in low- and middle-income countries where disparities in access to comprehensive stroke centres continue to pose substantial challenges [29].

Conclusion

In this tertiary-care North Indian cohort, CTA-confirmed large vessel occlusion was present in a substantial proportion of patients presenting with suspected acute ischemic stroke. Middle cerebral artery occlusion constituted the predominant vascular lesion, and hemiparesis emerged as the only independent clinical predictor of LVO. Non-contrast CT demonstrated high sensitivity and acceptable overall diagnostic accuracy for identifying patients with underlying arterial occlusion, supporting its continued role in acute stroke triage. The principal strength of this study lies in the integration of clinical presentation, vascular risk profiling, and CTA-confirmed imaging outcomes within a real-world tertiary-care setting. Nevertheless, the findings should be interpreted in light of certain limitations, including the single-centre design, modest sample size, and potential referral bias inherent to a specialized stroke centre. Larger prospective multicentre studies are warranted to validate these observations and refine predictive models for rapid identification of large vessel occlusion in diverse patient populations.

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