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Association Between Clinical Signs and Brain Computed Tomography Findings in Patients with Suspected Stroke at the University Clinics of Kinshasa

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ABSTRACT

Introduction
Stroke is a leading cause of mortality and long-term disability worldwide, particularly in low- and middle-income countries. Accurate differentiation between ischaemic stroke, haemorrhagic stroke, and stroke mimics is essential for appropriate management. In resource-limited settings, non-contrast brain computed tomography (CT) remains the primary imaging modality for confirming the diagnosis and guiding treatment decisions.

Purpose
To describe the clinical and brain CT characteristics of patients with suspected stroke and assess the association between clinical findings and CT-confirmed stroke at the University Clinics of Kinshasa.

Methods
A hospital-based descriptive and analytical cross-sectional study was conducted at the University Clinics of Kinshasa, Democratic Republic of the Congo, from January to June 2024. All eligible patients referred for brain CT because of clinically suspected stroke were consecutively enrolled. Sociodemographic, clinical, and comorbidity data were collected from medical records. Brain CT findings were classified as ischaemic stroke, haemorrhagic stroke, normal findings, or stroke mimics. Data were analysed using Stata/MP 17.0. Logistic regression was used to identify factors associated with CT-confirmed stroke.

Results
A total of 567 patients were included, with a mean age of 61.5 ± 14.2 years; 52.9% were male. Brain CT confirmed stroke in 336 patients (59.3%), while 81 (14.3%) had normal CT findings and 150 (26.4%) had stroke mimics. Among CT-confirmed strokes, 261 (77.7%) were ischemic and 75 (22.3%) were hemorrhagic. The most common clinical manifestations were limb motor deficit (64.4%), altered consciousness (58.7%), and headache (23.5%), whereas hypertension (81.7%) was the predominant comorbidity. In multivariable analysis, limb motor deficit (aOR = 1.73, 95% CI: 1.17–2.56; p = .006), language impairment (aOR = 2.52, 95% CI: 1.19–5.33; p = .016), and hypertension (aOR = 2.20, 95% CI: 1.41–3.43; p < .001) were independently associated with CT-confirmed stroke, whereas age ≥65 years was associated with lower odds of CT-confirmed stroke (aOR = 0.50, 95% CI: 0.33–0.75; p < .001).

Conclusion
Approximately two-fifths of patients clinically suspected of stroke did not have CT-confirmed stroke, highlighting the limitations of clinical assessment alone. Ischaemic stroke was the predominant subtype, and specific clinical features were significantly associated with CT-confirmed stroke. These findings reinforce the importance of brain CT for accurate diagnosis and differentiation of stroke subtypes in resource-limited settings.

INTRODUCTION

Stroke is a leading cause of death and long-term disability worldwide and remains a major public health challenge, particularly in low- and middle-income countries (Alwan, 2013; Owolabi et al., 2015). Despite advances in prevention and management, the global burden of stroke continues to increase owing to population growth, population ageing, and the rising prevalence of cardiovascular risk factors. In Africa, stroke accounts for a substantial proportion of neurological morbidity and mortality, with reported incidence rates among the highest globally, estimated at approximately 316 new cases per 100,000 population annually (Adeloye, 2014).

Prompt and accurate diagnosis is essential for effective stroke management because therapeutic strategies differ considerably between ischaemic and haemorrhagic stroke. Although several clinical tools, including the Siriraj Stroke Score, Allen Stroke Score, Bamford classification, and assessments derived from the National Institutes of Health Stroke Scale (NIHSS), have been developed to support clinical diagnosis and classification, their diagnostic performance remains variable, particularly in resource-constrained settings (Kolapo et al., 2006; Mwita et al., 2014). Furthermore, these tools do not consistently distinguish ischaemic stroke from haemorrhagic stroke with sufficient accuracy to guide definitive treatment decisions (Somasundaran et al., 2017).

Neuroimaging therefore plays a central role in the evaluation of patients with suspected stroke. Non-contrast brain computed tomography (CT) is widely recommended as the first-line imaging modality because it is rapid, accessible, and effective in differentiating ischaemic stroke from intracranial haemorrhage. In addition, CT enables the identification of stroke mimics and other intracranial pathologies that may present with acute neurological deficits. This distinction is particularly important in settings where access to magnetic resonance imaging (MRI), advanced vascular imaging, and specialised stroke services remains limited.

In many low-resource healthcare systems, including those in sub-Saharan Africa, clinical assessment often constitutes the initial basis for diagnosing stroke. However, reliance on clinical findings alone may result in diagnostic inaccuracies because several neurological and systemic conditions can mimic stroke presentations. Failure to accurately distinguish these conditions may lead to inappropriate treatment, delayed management, unnecessary referrals, and poorer patient outcomes.

Despite the growing burden of stroke in the Democratic Republic of the Congo, evidence regarding the relationship between clinical presentation and brain CT findings among patients with suspected stroke remains scarce. Most available data originate from other regions and may not fully reflect local epidemiological patterns, healthcare-seeking behaviours, or diagnostic practices. Generating context-specific evidence is therefore essential to inform clinical decision-making and optimise the use of available imaging resources.

Accordingly, this study aimed to describe the clinical and brain CT characteristics of patients with suspected stroke and to assess the association between clinical findings and CT-confirmed stroke at the University Clinics of Kinshasa.

METHODS

Study Design, Setting, and Period

This hospital-based descriptive and analytical cross-sectional study was conducted at the University Clinics of Kinshasa, a tertiary referral and teaching hospital in Kinshasa, Democratic Republic of the Congo. The study included patients referred for brain computed tomography (CT) because of clinically suspected stroke between January and June 2024.

CT examinations were performed using a 16-slice GE CT scanner available in the Department of Radiology and Medical Imaging of the University Clinics of Kinshasa.

Study Population and Eligibility Criteria

The study population comprised all patients referred for brain CT with a clinical suspicion of stroke during the study period. Eligible participants were recruited consecutively.

Patients were included if they were referred for brain CT on the basis of a clinical diagnosis or suspicion of stroke. For patients who underwent multiple CT examinations during the same episode of care, only the initial CT scan was retained for analysis to avoid duplication.

Patients referred for known intracranial tumours, traumatic brain injury, intracranial infections, or postoperative follow-up imaging were excluded.

Sample Size and Sampling Technique

No formal sample size calculation was performed because the study employed consecutive recruitment of all eligible patients presenting during the study period. This approach enabled the inclusion of the entire accessible population of patients with suspected stroke undergoing CT evaluation at the study site.

Data Collection

Data were extracted from patients' medical records using a semi-structured data collection form designed for the study.

The following information was collected:

i. Sociodemographic characteristics (age and sex);

ii. Clinical manifestations at presentation;

iii. Medical history and comorbidities;

iv. Brain CT findings.

To ensure data quality, completed forms were reviewed for completeness and consistency before data entry and analysis.

CT Acquisition and Image Interpretation

Brain CT examinations were acquired using a standard non-contrast protocol with helical axial image acquisition, a slice thickness of 5.0 mm, and multiplanar reconstructions of 1.5 mm.

CT images were reviewed by the principal investigator within the Department of Radiology and Medical Imaging to identify and classify radiological abnormalities. Findings were categorised as:

1. Ischaemic stroke;
2. Haemorrhagic stroke;
3. Normal CT findings; or
4. Stroke mimics.

Ischaemic strokes were further characterised according to disease phase (acute, subacute, chronic, or acute-on-chronic), anatomical distribution, and vascular territory. Haemorrhagic strokes were classified according to haemorrhage type and anatomical location.

Stroke mimics were defined as clinical or radiological conditions presenting with stroke-like symptoms but not corresponding to cerebral infarction or intracranial haemorrhage on CT imaging.

image interpretation was not subjected to systematic blinded double reading, interobserver agreement could not be assessed. This limitation is acknowledged in the Discussion section.

Study Variables

The primary outcome variable was CT-confirmed stroke, defined as the presence of either ischaemic stroke or haemorrhagic stroke on brain CT.

Independent variables included:

a) Age;

b) Sex;

c) Clinical manifestations;

d) Medical comorbidities.

For secondary analyses, stroke subtype (ischaemic versus haemorrhagic) was considered among patients with CT-confirmed stroke.

Statistical Analysis

Data were entered and analysed using Stata/MP version 17.0 (StataCorp LLC, College Station, TX, USA).

Categorical variables were summarised using frequencies and percentages, whereas continuous variables were described using means and standard deviations.

Bivariate logistic regression analyses were initially performed to identify factors associated with CT-confirmed stroke. Variables demonstrating clinical relevance or statistical significance at the bivariate level were subsequently considered for inclusion in a multivariable logistic regression model.

Associations were reported as odds ratios (ORs) with corresponding 95% confidence intervals (CIs). Statistical significance was established at $p < .05$.

Ethical Considerations

Ethical approval was obtained from the Ethics Committee of the School of Public Health of the University of Kinshasa under reference number ESP/CE/274/2025. Written informed consent was obtained from all participants or their legally authorised representatives before enrolment.

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Confidentiality and anonymity were maintained throughout data collection, analysis, and reporting, and no personally identifiable information was included in the study database or publication.

RESULTS

A total of 567 patients referred for clinically suspected stroke were included in the study. Men comprised 300 (52.9%) of the participants, and women comprised 267 (47.1%). The mean age was 61.5 ± 14.2 years. Patients younger than 65 years constituted 54.0% of the study population, whereas those aged 65 years or older accounted for 46.0% **(Table 1)**.

Table 1:
Demographic Characteristics of the Study Participants (N = 567)

Variable	n	%
Sex		
Male	300	52.9
Female	267	47.1
Age		
<65 years	306	54.0
≥65 years	261	46.0

The most common clinical manifestations were limb motor deficit (64.4%), altered consciousness (58.7%), and headache (23.5%). Hypertension (81.7%) was the most prevalent comorbidity, followed by diabetes mellitus (28.9%) **(Table 2)**.

Table 2:
Clinical Presentation and Comorbidities of the Study Participants (N = 567)

Variable	n	%
Clinical presentation		
Limb motor deficit	365	64.4
Altered consciousness	333	58.7
Visual disturbances (reduced or blurred vision)	13	2.3
Language impairment	56	9.9
Headache	133	23.5
Facial deviation	19	3.4
Seizures	79	13.9
Other*	14	2.4
Comorbidities		
None	19	3.4
Hypertension	463	81.7
Diabetes mellitus	164	28.9
Chronic kidney disease	9	1.6
Sickle cell disease	6	1.1

*Other signs included palpitations, chest tightness, dizziness, malaise, vomiting, neck stiffness, tremor, aphasia, incontinence with gait disturbance, epistaxis, and tinnitus.

Brain CT confirmed stroke in 336 patients (59.3%). Among the remaining patients, 81 (14.3%) had normal CT findings, whereas 150 (26.4%) had stroke mimics. Among CT-confirmed strokes, ischemic stroke predominated, accounting for 261 cases (77.7%), while hemorrhagic stroke accounted for 75 cases (22.3%) **(Table 3)**.

Table 3:
Brain CT Characteristics of Patients with CT-Confirmed Stroke (n = 336)

Distribution	n	%
Stroke subtype		
Hemorrhagic stroke	75	22.3
Ischemic stroke	261	77.7
Ischemic stroke stage (n = 261)		
Acute	139	53.3
Subacute	25	9.6
Chronic	93	35.6
Acute-on-chronic	4	1.5
Topography of ischemic stroke (n = 261)		
Territorial	155	59.4
Watershed	4	1.5
Lacunar	102	39.1
Type of intracranial hemorrhage (n = 75)		
Intracerebral/intraparenchymal hemorrhage	69	92.0
Subarachnoid hemorrhage	6	8.0
Location of intracerebral hemorrhage (n = 69)		
Supratentorial	57	82.6
Infratentorial	4	5.8
Intraventricular extension	8	11.6

Among the 150 patients with stroke mimics, cerebral atrophy (30.0%) and old infarction without an acute lesion (25.3%) were the most common diagnoses, together accounting for more than half of all stroke mimics. These findings underscore the value of brain CT in distinguishing acute stroke from chronic cerebrovascular and degenerative conditions that may present with similar clinical manifestations **(Table 4)**.

Table 4:
Distribution of Stroke Mimics on Brain CT (n = 150)

Stroke mimic	n	%
Cerebral atrophy	45	30.0
Brain tumor	12	8.0
Encephalopathy	22	14.7
Hydrocephalus	18	12.0
Old infarction without an acute lesion	38	25.3
Other diagnoses	15	10.0
Total	**150**	**100.0**

In the multivariable complete-case analysis (n = 546), limb motor deficit (aOR = 1.73, 95% CI: 1.17–2.56; p = .006), language impairment (aOR = 2.52, 95% CI: 1.19–5.33; p = .016), and hypertension (aOR = 2.20, 95% CI: 1.41–3.43; p < .001) were independently associated with CT-confirmed stroke. Conversely, patients aged 65 years or older had lower odds of CT-confirmed stroke than those younger than 65 years (aOR = 0.50, 95% CI: 0.33–0.75; p < .001) **(Table 5)**.

Table 5:
Multivariable Logistic Regression Analysis of Factors Associated with CT-Confirmed Stroke (Complete-Case Analysis, n = 546)

Variable	Category	**No stroke**, n (%)	**Stroke**, n (%)	**aOR** (95% CI)	*p*
Age	<65 years	107 (35.0)	199 (65.0)	1.00	—
	≥65 years	124 (47.5)	137 (52.5)	0.50 (0.33–0.75)	<.001
Sex	Female	115 (43.1)	152 (56.9)	1.00	—
	Male	116 (38.7)	184 (61.3)	1.19 (0.83–1.71)	.342
Clinical presentation	Limb motor deficit	132 (36.1)	234 (63.9)	1.73 (1.17–2.56)	.006
	Altered consciousness	167 (42.0)	231 (58.0)	1.30 (0.76–2.23)	.344
	Visual disturbances	5 (38.5)	8 (61.5)	1.41 (0.42–4.76)	.579
	Language impairment	14 (25.0)	42 (75.0)	2.52 (1.19–5.33)	.016
	Headache	52 (39.1)	81 (60.9)	1.04 (0.63–1.72)	.881
	Facial deviation	8 (42.1)	11 (57.9)	1.42 (0.49–4.09)	.521
	Seizures	33 (41.8)	46 (58.2)	1.02 (0.61–1.72)	.931
Comorbidities	Hypertension	150 (36.0)	267 (64.0)	2.20 (1.41–3.43)	<.001
	Diabetes mellitus	60 (39.5)	92 (60.5)	1.07 (0.68–1.69)	.761

Note: Adjusted odds ratios (aORs) were obtained from a multivariable logistic regression model using complete-case analysis (n = 546). Percentages are calculated by row. The reference category for each variable is indicated by an aOR of 1.00. Variables with sparse data were excluded from the multivariable model.

Among patients with CT-confirmed stroke and complete data (n = 330), limb motor deficit was independently associated with ischemic stroke (aOR = 1.95, 95% CI: 1.07–3.55; p = .030). In contrast, altered consciousness (aOR = 0.15, 95% CI: 0.05–0.41; p < .001) and headache (aOR = 0.43, 95% CI: 0.19–0.96; p = .040) were inversely associated with ischemic stroke and were therefore relatively more common among patients with hemorrhagic stroke **(Table 6)**.

Table 6:
Multivariable Logistic Regression Analysis of Factors Associated with Ischemic Stroke Among Patients with CT-Confirmed Stroke (Complete-Case Analysis, n = 330)

Variable	Category	**Hemorrhagic, n (%)**	**Ischemic, n (%)**	**aOR (95% CI)**	*p*
Age	<65 years	51 (25.6)	148 (74.4)	1.00	—
	≥65 years	24 (17.5)	113 (82.5)	1.73 (0.88–3.38)	.109
Sex	Female	31 (20.4)	121 (79.6)	1.00	—
	Male	44 (23.9)	140 (76.1)	0.75 (0.43–1.33)	.330
Clinical presentation	Limb motor deficit	41 (17.5)	193 (82.5)	1.95 (1.07–3.55)	.030
	Altered consciousness	66 (28.6)	165 (71.4)	0.15 (0.05–0.41)	<.001
	Visual disturbances	2 (25.0)	6 (75.0)	0.71 (0.12–4.34)	.710
	Language impairment	5 (11.9)	37 (88.1)	0.76 (0.23–2.49)	.653
	Headache	17 (21.0)	64 (79.0)	0.43 (0.19–0.96)	.040
	Facial deviation	3 (27.3)	8 (72.7)	0.76 (0.15–3.89)	.737
	Seizures	7 (15.2)	39 (84.8)	1.77 (0.70–4.50)	.227
Comorbidities	Hypertension	61 (22.8)	206 (77.2)	0.68 (0.32–1.43)	.303
	Diabetes mellitus	18 (19.6)	74 (80.4)	1.27 (0.60–2.72)	.532

Note: Adjusted odds ratios (aORs) were obtained from a multivariable logistic regression model using complete-case analysis (n = 330). Percentages are calculated by row. An aOR >1 indicates higher odds of ischemic stroke relative to hemorrhagic stroke.

DISCUSSION

This study evaluated the association between clinical findings and brain CT results among patients with clinically suspected stroke at the University Clinics of Kinshasa. Brain CT confirmed stroke in 59.3% of patients, whereas 40.7% had either normal CT findings or alternative diagnoses classified as stroke mimics. These findings demonstrate the limitations of clinical assessment alone and reinforce the indispensable role of brain CT in establishing an accurate diagnosis, differentiating stroke subtypes, and identifying conditions that mimic acute stroke.

The mean age of the study population was 61.5 ± 14.2 years, which is consistent with reports from other African studies indicating that stroke predominantly affects older adults (Fekadu et al., 2019; Nakibuuka et al., 2012). Age-related vascular changes, cumulative exposure to cardiovascular risk factors, and progressive atherosclerosis contribute substantially to stroke risk (Yousufuddin & Young, 2019). Although patients aged 65 years or older had a higher crude proportion of ischemic stroke than hemorrhagic stroke, age was not independently associated with stroke subtype after multivariable adjustment. Conversely, age ≥65 years was independently associated with lower odds of CT-confirmed stroke among all patients referred for suspected stroke.

Limb motor deficit, altered consciousness, headache, and language impairment were the most common clinical manifestations. Multivariable analysis demonstrated that limb motor deficit and language impairment were independently associated with CT-confirmed stroke, supporting previous studies that identified focal neurological deficits as the most reliable clinical indicators of acute stroke (Murphy & Werring, 2020; Ojaghihaghighi et al., 2017).

Approximately one-quarter of patients had stroke mimics, with cerebral atrophy and old cerebral infarction without an acute lesion representing the most frequent diagnoses. These findings highlight the importance of brain CT in distinguishing acute stroke from chronic cerebrovascular disease and other neurological disorders that may present with similar clinical manifestations. Failure to identify these conditions may result in inappropriate treatment and delayed management of the underlying disease.

Headache was frequently reported but was not independently associated with CT-confirmed stroke. In the subtype analysis, however, headache was relatively more common among patients with hemorrhagic stroke than among those with ischemic stroke. Because headache is a nonspecific neurological symptom, it should be interpreted alongside focal neurological deficits and neuroimaging findings rather than used in isolation to establish a diagnosis (León Cejas et al., 2019).

Hypertension was the most prevalent comorbidity and was independently associated with CT-confirmed stroke. This finding is consistent with extensive evidence identifying hypertension as the leading modifiable risk factor for both ischemic and hemorrhagic stroke worldwide (An et al., 2017; Rukn et al., 2019). Strengthening hypertension screening, treatment, and long-term control should therefore remain a public health priority in the Democratic Republic of the Congo.

Ischemic stroke accounted for more than three-quarters of CT-confirmed strokes, whereas hemorrhagic stroke represented approximately one-fifth of cases. This distribution is broadly consistent with global epidemiological trends and with reports from several African countries, although the proportion of hemorrhagic stroke remains relatively high in many low-resource settings because of suboptimal hypertension control (Fekadu et al., 2018; Gedefa et al., 2017; Nakibuuka et al., 2012; Olum et al., 2021).

Compared with magnetic resonance imaging, non-contrast brain CT is more widely available, less expensive, and capable of rapidly differentiating ischemic stroke from intracranial hemorrhage while simultaneously identifying important stroke mimics. These advantages make CT the cornerstone of acute stroke evaluation in many resource-limited healthcare settings and support its routine integration into the diagnostic pathway for patients presenting with suspected stroke.

Study Limitations

This study has several limitations. First, it was conducted at a single tertiary referral hospital, which may limit the

generalizability of the findings to other healthcare settings in the Democratic Republic of the Congo. Second, the inclusion of only patients referred for CT imaging may have introduced selection bias. Third, non-contrast brain CT has limited sensitivity for detecting very early, small, or posterior fossa ischemic infarctions. Fourth, CT interpretation was performed primarily by a consultant radiologist without systematic blinded double reading, introducing the possibility of observer bias. Finally, the retrospective cross-sectional design precluded assessment of clinical progression, functional outcomes, and long-term mortality and may have been subject to incomplete documentation in routine medical records.

Practical Implications

The findings support the systematic integration of non-contrast brain CT into the initial evaluation of patients with suspected stroke at the University Clinics of Kinshasa and other healthcare facilities with CT capability. They also underscore the need to strengthen recognition of focal neurological deficits, improve hypertension prevention and control, expand access to emergency neuroimaging, and develop organized stroke-care pathways to improve diagnosis and patient outcomes in resource-limited settings.

Data Availability: Anonymized data are available upon reasonable request to the corresponding author, subject to restrictions based on the conditions of the original participant consent.

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Informed Consent: *Consent Type:* Waiver of active written consent was approved for this retrospective study using archived records. *Anonymization:* Data were fully anonymized prior to analysis to protect participant confidentiality.

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