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ORIGINAL RESEARCH

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Correlation between clinical and brain computed tomography findings of stroke patients: A cross-sectional study

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Abstract

Background and Aims: In developing countries, the burden of stroke is growing and causing significant morbidity and disability with high mortality rates. Neuroimaging plays a crucial role in differentiating ischemic stroke from an intracerebral hemorrhage, as well as entities other than stroke. This study sought to determine the correlation between the clinical and brain CT scan findings of stroke patients attending three hospitals in Kampala, Uganda.

Methods: This was a cross-sectional study of clinically suspected stroke patients who were sent for brain CT scan at three selected hospitals in Kampala, Uganda. All brain CT scans of patients with suspected stroke were evaluated and the Alberta stroke program early CT score (ASPECTS) was used for middle cerebral artery (MCA) strokes. Univariate analysis was used to describe the clinico-demographic and brain CT features of stroke and summarized them as percentages. Bivariate and multivariate analysis were used to determine the adjusted odds ratios as a measure of association with a 95% confidence interval (CI).

Results: Of the 270 study participants, 141 (52.2%) were male. 162 (60%) had CT findings of stroke, and 90 (33.3%) had normal brain CT findings. Eighteen (6.7%) had other CT findings like tumor, dural hemorrhage, epidermoid cyst, and others. Ischemic stroke, hemorrhagic stroke, and subarachnoid hemorrhage accounted for 124 (45.9%), 34 (12.6%), and 4 (1.5%) respectively. Limb weakness (55.2%), headache (41.1%), and loss of consciousness (39.3%) were associated with stroke findings on CT. Among the acute ischemic strokes, 30 (73.2%) had a worse (0–7) ASPECT score. Those aged ≥65 years were associated with a worse ASPECTS [AOR: 22.01, (95% CI: 1.58–306.09) $p = 0.021$].

Conclusion: More than a third of patients with a clinical diagnosis of stroke had either no CT features of stroke or had other findings. The most commonly affected vascular territory was left MCA. Old age was strongly associated with having the worst ASPECTS score.

KEYWORDS

ASPECT score, computed tomography, hemorrhagic, ischemic, stroke

1 | BACKGROUND

The growing burden of chronic noncommunicable diseases (NCDs) including stroke in developing countries is appalling.[1] Increasing longevity, harmful dietary transformation, and an increasing prevalence of risk factors such as hypertension, obesity, and diabetes have been implicated in the rising stroke trends.[2,3] In the last decade, stroke has become one of the leading global causes of premature death and is a major cause of mortality, morbidity, and permanent disability.[1,4] The overall prevalence of stroke in Africa is among the world's highest, estimated at 316 new cases each year per 100,000 people.[5] However, this varies greatly among individual countries. The WHO estimates that by 2030, 80% of all stroke will occur in people living in low and middle-income countries, where it will account for about 7.9% of all mortality.[6,7] The stroke related mortality in Uganda is approximately 26.8% deaths per month, 50% in Tanzania and 27% in Gambia.[8–10]

Based on clinical and neurological findings, several scores have been developed to aid diagnosis, categorization, and prognostication of stroke in the absence of neuroimaging. Some include; the Siriraj score (type of stroke), Bamford (clinical syndrome) stroke categories, Allen Stroke score (Guy Hospital score), modified NIHSS severity scores, and so forth.[11,12] However, all these clinical scores have been criticized for high variability (50%–90%) and are not reliable to guide clinicians in stroke management because they cannot be used to differentiate ischemic from hemorrhagic stroke.[13,14]

The role of neuroimaging in stroke management is fundamental and stretches far beyond diagnosis to offering insight into the underlying mechanisms and hence guiding decision-making concerning therapeutic intervention. Noncontrasted computerized tomography (NCCT) scan is recommended as the first-line imaging modality for stroke, to differentiate stroke subtypes and exclude stroke mimics.[13] It is fast, relatively available, cost-effective and does not require the use of intravenous contrast.[15] NCCT is associated with a relatively low effective radiation dose of about 1.7 mSv which is way below the critical dose for organ damage like cataracts, hair loss, and so forth. Therefore, the benefit of NCCT in stroke diagnosis outweighs the risk of radiation exposure.[16]

The "Alberta stroke program early CT score (ASPECTS)" system for MCA and a similar score for posterior circulation (Pc-ASPECTS) are used to evaluate large infarctions to guide treatment.[17] The ASPECTS is a 10-point quantitative topographic CT scan score used for patients with MCA stroke.[18] An ASPECTS score less than or equal to 7 predicts a worse functional outcome at 3 months as well as symptomatic hemorrhage.[18] The scoring system is based on segmental estimation of the MCA vascular territory.[19] One (1) point is deducted from the initial score of 10 for every region involved. The regions include; caudate(C), putamen (P), internal capsule (IC), insular cortex (I), M1: "anterior MCA cortex," corresponding to the frontal operculum, M2: "MCA cortex lateral to insular ribbon" corresponding to the anterior temporal lobe, M3: "posterior MCA cortex" corresponding to the posterior temporal lobe, M4: "anterior MCA territory immediately superior to M1," M5: "lateral MCA territory immediately superior to M2," and M6: "posterior MCA territory immediately superior to M3."

Regarding the aforementioned, knowledge of the clinical and neuroimaging profile of stroke patients is essential for appropriate therapeutic intervention and policy making. Moreover, in Uganda, there was limited data on this subject and we rely on studies taken from the western countries which may not be representative, because of sociodemographic variations. Hence, this study sought to describe and assess the association between the clinical and brain CT features of stroke at the selected centers in Kampala, Uganda.

2 | METHODS

2.1 | Study design and setting

This was a cross-sectional study conducted at three hospitals in Kampala, Uganda between July and October 2021. The three hospitals are located in different parts of Kampala and cover different areas of catchment. These hospitals have an internal medicine department with neurologists and CT scan services for the referred patients with neurologic deficits. One of the hospitals was public, the second was private and the third was private-not-for-profit.

2.2 | Study population

All patients with a clinical diagnosis of stroke referred for brain CT at the three selected hospitals in Kampala, Uganda during the study period were recruited. The inclusion criteria were, all patients who were sent for brain CT scan with a clinical diagnosis of stroke and for those who have been sent for follow-up brain CT scan, the first brain CT scan was included in the study. The exclusion criteria were, patients who were sent for brain CT scan with known intracranial neoplasm, trauma, intracranial infection, or postoperative follow-up.

TABLE 1 Demographic characteristics.

	Frequency (*n*)	Percentage (%)
Sex		
Male	141	52.2
Female	129	47.8
Age		
15–24	9	3.3
25–34	15	5.6
35–44	39	14.4
45–54	50	18.5
55–64	66	24.4
≥65	91	33.7
Life style		
Smoking	2	0.7
Alcohol	25	9.2

2.3 | Sample size

The sample size was determined using the Kish Leslie formula:

$N = Z^2\ P\ (1\text{-}P)/d^2$, where;

N = the required sample size.

Z = the standard normal value corresponding to 95% confidence interval (1.96).

d = the required precision of the estimate (0.05).

P = The proportion of patients with ischemic stroke is 77.6%.[20]

N = 270 participants.

2.4 | Study procedure

Every patient with a clinical diagnosis of stroke sent for brain CT was consecutively recruited. The data on sociodemographics and clinical signs/symptoms of stroke was obtained using a semistructured form.

TABLE 2 Clinical presentation of patients.

	Frequency (*n*)	Percentage (%)
Clinical presentation		
Limb weakness	149	55.2
Loss of consciousness	106	39.3
Loss/blurred vision	35	13.0
Altered speech	85	31.5
Headache	111	41.1
Reduced level of consciousness	46	17.0
Facial deviation	16	5.9
Convulsions	10	3.7
Others[a]	19	7.0
Duration of symptoms		
≤1 week	233	86.3
1 month	21	7.8
≥1 month	16	5.9
Comorbidities		
None	54	20.0
Hypertension	157	58.1
Diabetes mellitus	3	1.1
Hypertension+ diabetes Mellitus	56	20.7
HIV	6	2.2
Chronic kidney disease (CKD)	3	1.1
Parkinson's	1	0.4
Sickle cell Disease	1	0.4

[a]Palpitations and chest tightness (1), dizziness (3), malaise (1), vomiting (7), neck stiffness (1), tremors (2), aphasia (1), incontinence with altered gait (1), nose bleeding (1), and tinnitus (1).

The clinical findings were collected from medical records. Brain CT scans of patients were acquired using 32 slices, 16 slices, and 128 slices Siemens CT scanners, respectively at the three hospitals. The images were acquired in helical axial 5.0 mm slice thickness and then reconstructed into 1.5 mm multiplanar reformats. In this study,

TABLE 3 Cranial CT features of the stroke patients.

Distribution	Frequency (*n*)	Percentage (%)
Hemispheric distribution (*n* = 180)		
Right	64	35.6
Left	81	45.0
Bilateral	35	19.4
Localization (*n* = 180)		
Frontal	10	5.6
Parietal	46	25.6
Temporal	2	1.1
Occipital	4	2.2
Subcortical gray matter	6	3.3
Cerebellum	7	3.9
Multilobar	34	18.9
Midbrain	1	0.6
Pons	1	0.6
Thalamo-ganglionic	38	21.1
Intraventricular	4	2.2
Vascular territorial distribution (*n* = 180)		
Vertebral basilar artery	3	1.7
ACA	6	3.3
MCA	138	76.7
PCA	13	7.2
Multiple vascular territories	20	11.1
Early ischemic changes (EIC) (*n* = 124)		
Sulcal effacement	40	32.3
Basal ganglia hypodensity	18	14.5
Loss of gray white-matter differentiation	50	40.2
Age of the stroke (*n* = 162)		
Acute stroke	93	57.4
Subacute stroke	12	7.4
Chronic stroke	53	32.7
Acute on chronic stroke	4	2.5
Aspect score (*n* = 70)		
Better (8–10)	14	20.0
Worse (0–7)	56	80.0

Abbreviation: MCA, middle cerebral artery.

sedation was not applied before scanning since all the patients were generally stable during scanning. Then the primary investigator, evaluated the brain CT scans of the patients for any abnormality. The brain CT scans with positive findings were then categorized as ischemic, hemorrhagic or others. Those who had ischemic findings were further categorized according to hemisphere involved, anatomical localization, vascular territory, age of the stroke, and additional findings. Finally, the ASPECT score was calculated out of 10, by subtracting a point for each area involved.

2.5 | Statistical analysis

Data entry was done using REDCap an online software and analysis using Stata version 16 statistical software. Univariate analysis was used to describe the clinical profile (clinico-demographic) and brain CT features of stroke and summarized them as frequencies and percentages. Logistic regression analysis was done at bivariate and multivariate levels to determine the factors associated with stroke and worse ASPECT score outcomes and reported both crude and adjusted odds ratios with their 95% confidence intervals (CI) and *p* values. Statistical significance was determined at $p < 0.05$.

3 | RESULTS

A total of 270 brain CT scans of patients clinically diagnosed with stroke in the three selected hospitals were analyzed.

Eighteen (6.7%) had a brain tumor, cerebral atrophy, subdural hematoma, and frontal arachnoid cyst on brain CT. There were 141

TABLE 4 Comparing clinico-demographic features with CT diagnosis of stroke patients.

	No stroke	Stroke	OR (95% CI)	*p* Value
Age				
<65 years	78 (43.6)	101 (56.4)	1	
≥65 years	30 (32.9)	61 (67.0)	1.57 (0.92–2.66)	0.094
Alcohol				
No	107 (39.9)	161 (60.1)	1	
Yes	17 (68.0)	8 (32.0)	0.28 (0.12–0.67)	0.003
Sex				
Female	52 (40.3)	77 (59.7)	1	
Male	56 (39.7)	85 (60.3)	1.03 (0.63–1.67)	0.921
Clinical presentation				
Limb weakness	40 (26.8)	109 (73.2)	3.49 (2.10–5.82)	<0.001
Loss of consciousness	46 (43.4)	60 (56.6)	0.79 (0.48–1.30)	0.360
Loss/blurred vision	6 (17.1)	29 (82.9)	3.71 (1.48–9.26)	0.005
Altered speech	18 (21.1)	67 (78.8)	3.53 (1.94–6.39)	<0.001
Headache	56 (50.5)	55 (49.5)	0.47 (0.29–0.78)	<0.003
Reduced level of consciousness	16 (34.8)	30 (65.2)	1.31 (0.67–2.53)	0.428
Facial deviation	12 (75.0)	4 (25.0)	0.20 (0.06–0.64)	0.007
Convulsions	3 (30.0)	7 (70.0)	1.58 (0.40–6.25)	0.514
Duration of symptoms				
≤1 week	96 (41.2)	137 (58.8)	1	
1 month	7 (33.3)	14 (66.7)	1.40 (0.54–3.60)	0.483
≥1 month	5 (31.2)	11 (68.8)	1.54 (0.51–4.58)	0.436
Comorbidities				
None	29 (53.7)	25 (46.3)	1	
Hypertension	56 (35.7)	101 (64.3)	2.09 (1.11–3.91)	0.021
Diabetes mellitus	2 (66.7)	1 (33.3)	0.58 (0.05–6.78)	0.664
HTN+ DM	21 (37.5)	35 (62.5)	1.93 (0.90–4.14)	0.089

(52.2%) males and 129 (47.8%) females, with a mean age of 56.9 ± 16.3 years (Table 1). The commonest clinical features of stroke were; unilateral limb weakness (*n* = 149, 55.2%), headache (*n* = 111, 41.1%) and loss of consciousness (*n* = 106, 39.3%). Most patients (*n* = 233, 86.3%) had a brain CT scan done in less than a month since the onset of the symptoms. Hypertension was the commonest medical condition accounting for 157 (58.1%) patients whereas diabetes mellitus was recorded in only 3 (1.1%) patients (Table 2).

Of all the patients clinically diagnosed with stroke, 162 (60%) had brain CT findings of stroke, and 90 (33.3%) patients demonstrated normal brain CT features. Among the 162 patients with confirmed stroke, 124 (76.5%) had an ischemic stroke, 34 (20.9%) had hemorrhagic and 4 (2.6%) had subarachnoid hemorrhage.

The left cerebral hemisphere was the most common site for stroke 81 (45.0%), and bilateral cerebral involvement was observed in 35 (19.4%) of the patients. In terms of lobar involvement, the parietal lobe was the most involved 46 (25.6%) while 34 (18.9%) had multilobar involvement. The most commonly involved vascular territory was MCA accounting for 138 (76.7%) while 20 (11.1%) had multiple vascular territories involvement.

Majority of the patients had acute stroke accounting for 57.4% (*n* = 93). The subacute, chronic and acute on chronic stroke accounted for 12 (7.4%), 53 (32.72%), and 4 (2.47%), respectively. The majority 56 (80%) of the patients with acute ischemic stroke had worse ASPECT scores (0–7) and 14 (20%) showed better ASPECTS.[8–10]

The commonest early ischemic change was the loss of gray-white matter differentiation 50 (40.2%), followed by sulcial effacement 40

TABLE 5 Comparing clinico-demographic features with type of stroke.

	Hemorrhagic	Ischemic	OR (95% CI)	*p* Value
Age				
<65 years	30 (29.7)	71 (70.3)	1	
≥65 years	8 (13.1)	53 (86.9)	2.80 (1.18–6.60)	0.019
Alcohol				
No	33 (21.4)	121 (78.6)	1	
Yes	5 (62.5)	3 (37.5)	0.16	0.017
Sex				
Female	14 (18.2)	63 (81.8)	1	
Male	24 (28.2)	61 (71.8)	0.56 (0.26–1.19)	0.132
Clinical presentation				
Limb weakness	23 (21.1)	86 (78.9)	1.48 (0.69–3.13)	0.312
Loss of consciousness	17 (28.3)	43 (71.7)	0.66 (0.31–1.37)	0.263
Loss/blurred vision	9 (31.0)	20 (68.9)	0.61 (0.25–1.51)	0.291
Altered speech	13 (19.4)	54 (80.6)	1.48 (0.69–3.17)	0.306
Headache	20 (36.4)	35 (63.6)	0.35 (0.17–0.74)	0.005
Reduced level of consciousness	16 (53.3)	14 (46.7)	0.175 (0.07–0.41)	<0.001
Facial deviation	0 (0)	4 (100)	-	-
Convulsions	1 (14.9)	6 (85.7)	1.88 (0.21–16.13)	0.558
Duration of symptoms				
≤1 week	36 (26.2)	101 (73.7)	1	
1 month	2 (14.3)	12 (85.7)	2.18 (0.45–10.02)	0.335
≥1 month	0 (0)	11 (100.0)	-	-
Comorbidities				
None	6 (24.0)	19 (76.0)	1	
Hypertension	28 (27.7)	73 (72.3)	0.82 (0.29–2.27)	0.021
Diabetes Mellitus	0 (0)	1 (100.0)	-	-
HTN+ DM	4 (11.4)	31 (88.6)	2.4 (0.61–9.81)	0.206

(32.2%) and basal ganglia hypodensity accounting for 18 (14.5%) (Table 3). The majority of the patients showed features of acute stroke (93%) irrespective of the type of stroke while acute on chronic stroke were the least (4%).

The patients who clinically presented with limb weakness, loss or blurred vision, altered speech, and reduced level of consciousness showed a statistically significant association with having a stroke ($p < 0.05$). In addition, a reduced level of consciousness was statistically significant with having an ischemic stroke (AOR: 0.12(95% CI: 0.03–0.44; $p = 0.001$). The age above 65 years was associated with having worse ASPECTS with an adjusted odd ratio of 22.01 (95% CI: 1.58–306.09; $p = 0.021$).

The clinico-demographic features and cranial CT findings of the patients were compared using both bivariate and multivariate analysis (Tables 4–7).

Examples of ischemic and hemorrhagic strokes are demonstrated in Figures 1–3.

4 | DISCUSSION

This study sought to determine the clinico-demographic and brain CT scan findings of stroke patients attending three hospitals in Kampala, Uganda. The study found that more than half were over the age of 55 years with the majority aged above 65 years. Age has been reported as the strongest nonmodifiable risk factor for ischemic stroke due to atherosclerosis and a high occurrence of silent cerebrovascular disease.[21,22] In contrast, our stroke patients seem to be younger (mean age of 63.2 years) than the Asian and western counterparts.[8,10,23] These results talk about the early burden of stroke in our population, where some patients present at a younger age. In this study, unilateral limb weakness was the most frequent presentation of stroke, followed by headache and loss of consciousness. These findings reaffirm that clinical evaluation through history and physical examination remains the cornerstone of stroke evaluation. Moreover, the findings were consistent with other studies regarding the

TABLE 6 Comparing clinico-demographic features with ASPECTS outcome.

	Better	Worse	OR (95% CI)	*p* Value
Age				
<65 years	11 (26.8)	30 (73.2)	1	
≥65 years	3 (10.3)	26 (89.7)	3.18 (0.80– 12.63)	0.101
Sex				
Female	6 (18.7)	26 (81.3)	1	
Male	8 (21.1)	30 (78.9)	0.86 (0.26–2.82)	0.810
Clinical presentation				
Limb weakness	10 (20.0)	40 (80.0)	1.0 (0.27–3.65)	>0.990
Loss of consciousness	6 (23.1)	20 (76.9)	0.74 (0.42–2.43)	0. 621
Loss/blurred vision	3 (25.0)	9 (75.0)	0.71 (0.16–3.03)	0.636
Altered speech	6 (20.7)	23 (79.3)	0.93 (0.28–3.04)	0.903
Headache	5 (20.0)	20 (80.0)	1.0	>0.990
Reduced level of consciousness	1 (12.5)	7 (87.5)	1.86 (0.20–16.47)	0.578
Facial deviation	2 (100.0)	0 (0)	-	-
Convulsions	0 (0.0)	3 (100.0)	-	-
Duration of symptoms				
≤1 week	12 (18.8)	52 (81.2)	1	
1 month	1 (20.0)	4 (80.0)	-	-
≥1 month	1 (100.0)	0 (0)	-	-
Comorbidities				
None	1 (11.1)	8 (88.9)	1	
Hypertension	8 (18.2)	36 (81.8)	0.56 (0.61–5.15)	0.611
Diabetes mellitus	-	1 (100.0)	-	-
HTN+ DM	5 (31.1)	11 (68.8)	0.27 (0.02–2.83)	0.278

TABLE 7 Multivariate analysis.

	Stroke AOR (95% CI)	(*p* Value)	Ischemic AOR (95% CI)	(*p* Value)	Worse ASPECT score AOR (95% CI)	(*p* Value)
Age						
<65 years	1		1		1	
≥65 years	1.14 (0.55–2.37)	0.717	2.42 (0.77–7.57)	0.129	22.01 (1.58–306.09)	0.021*
Sex						
Female						
Male	0.89 (0.45–1.73)	0.736	1.01 (0.37–2.71)	0.980	0.64 (0.12–3.36)	0.599
Alcohol						
No	1		1		1	
Yes	0.40 (0.11–1.53)	0.183	0.30 (0.04–2.35)	0.255	-	-
Clinical presentation						
Limb weakness	4.12 (1.98–8.55)	<0.001*	0.49 (0.17–1.45)	0.201	0.45 (0.06–3.45)	0.439
Loss of consciousness	1.70 (0.81–3.59)	0.160	0.46 (0.16–1.36)	0.163	0.62 (0.11–3.60)	0.590
Loss/blurred vision	6.52 (1.90–22.36)	0.003*	0.41 (0.12–1.45)	0.169	0.11 (0.01–1.21)	0.071
Altered speech	2.58 (1.22–5.46)	0.013*	1.30 (0.43–3.92)	0.633	3.73 (0.49–28.56)	0.205
Headache	0.66 (0.33–1.29)	0.224	0.43 (0.16–1.17)	0.102	3.35 (0.41–27.56)	0.260
Reduced level of consciousness	5.13 (1.76–15.02)	0.003*	0.12 (0.03–0.44)	0.001*	0.58 (0.03–10.75)	0.720
Facial deviation	0. 61 (0.12–3.04)	0.548	-	-	-	-
Convulsions	4.69 (0.80–27.63)	0.087	0.50 (0.31–5.88)	0.087	0.50 (0.31–5.88)	0.087
Duration of symptoms						
≤1 week	1		1		1	
1 month	0.64 (0.19–2.12)	0.466	2.94 (0.31–28.12)	0.349	0.10 (0.01–3.60)	0.193
≥1 month	1.09 (0.26–4.45)	0.908	-	-	-	-
Comorbidities						
None	1		1		1	
Hypertension	4.0 (0.71–22.41)	0.115	0.34 (0.71–22.41)	0.116	3.82 (0.60–24.01)	0.153
Diabetes mellitus	2.88 (0.11–76.61)	0.526	-	-	-	-
Hypertension+ diabetes mellitus	2.49 (0.43–14.4)	0.308	-	-	-	-

Abbreviation: ASPECTS, Alberta stroke programme early CT score.
*Statistically significant ($p < 0.05$).

neurological manifestation of stroke.[24] This further aligned well with other studies that reported a 34%–36% prevalence of headache among stroke patients.[25] However, although headache was common among stroke patients, it was equally common even among those without CT features of stroke. Conversely even though headache was associated with a low NHISS score, it was also associated with an erroneous diagnosis of strokes.[26]

The majority of our patients came within weeks from the onset of the clinical features to the time of brain CT imaging. This is in contrast to the findings of a study done in Mbarara regional referral hospital by Olum et al.[27] in which the average time from symptom onset to presentation at the hospital was 3 days, with no significant difference between male and female patients. This could be due to the fact that most patients tend to seek health care as their condition or weakness worsens. And the other contributing factor for the late presentation for neuroimaging could be due to time lost during the referral of patients, since the study was conducted in hospitals at a tertiary level.

Hypertension was the most common prevailing comorbidity recorded. It was seen in two-thirds of the ischemic strokes and one-third of the hemorrhagic strokes. This finding is consistent with reports from prior studies where hypertension was the most important or prevalent risk factor for stroke.[28,29] However, in comparison to other studies, other established risk factors for stroke such as diabetes mellitus and smoking were less common in this study.[30,31]

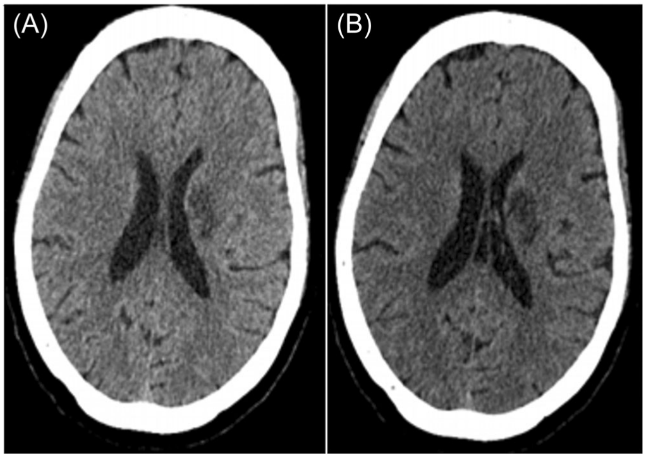

FIGURE 1 (A, B) Axial NCCT of a 67-year female hypertensive with sudden limb weakness, confusion, and speech difficulties demonstrating a hypodense lesion involving the head and body of the left caudate nucleus and centrum semiovale in keeping with an ischemic infarct. NCCT, noncontrasted computerized tomography.

Ischemic stroke was the predominant type followed by hemorrhagic stroke and subarachnoid hemorrhage. These findings conform with both local and global trends of stroke types reported by previous studies.[27,32] The high incidence of ischemic stroke is probably due to the multiple risk factors associated with ischemic stroke, as opposed to hemorrhagic stroke where hypertension is the sole most significant risk factor. However, higher incidences of hemorrhagic stroke have been reported in some African countries.[33,34] The study further shows that a third of patients clinically diagnosed with stroke did not have CT findings of stroke. The accuracy was not computed because this study did not independently assess the clinical findings of stroke and therefore the reliability of the clinical diagnosis could not be validated. Nevertheless, the findings conform with other studies where the difference was attributed to the variation of NCCT sensitivity as the time from onset of symptoms increases.[35,36]

Left sided stroke was the most common in the study population. This is in agreement with the findings of other studies where the predominance of left-sided stroke was documented.[37,38] In contrast,

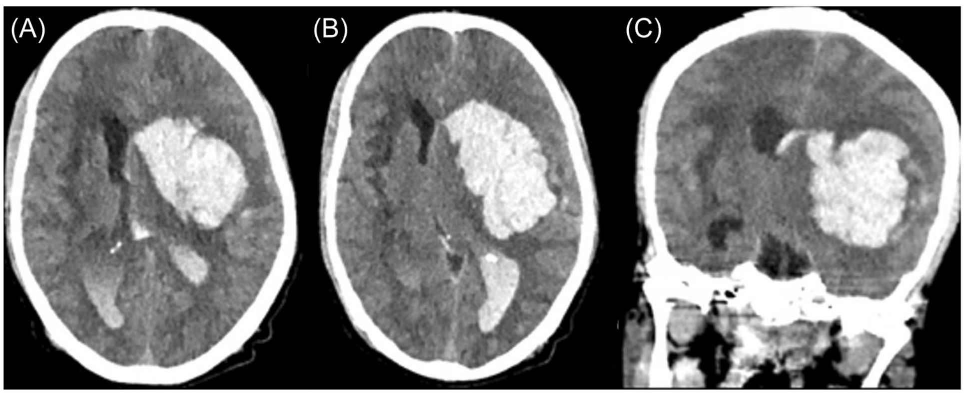

FIGURE 2 (A, B) Axial and (C) coronal NCCT of a 39-year-old male, hypertensive with severe headache, blurred vision and later on coma, demonstrating large hyperdense mass in the left cerebral hemisphere extending to the posterior horns of the bilateral lateral ventricles with marked midline shift to the right in keeping with a hemorrhagic stroke. NCCT, noncontrasted computerized tomography.

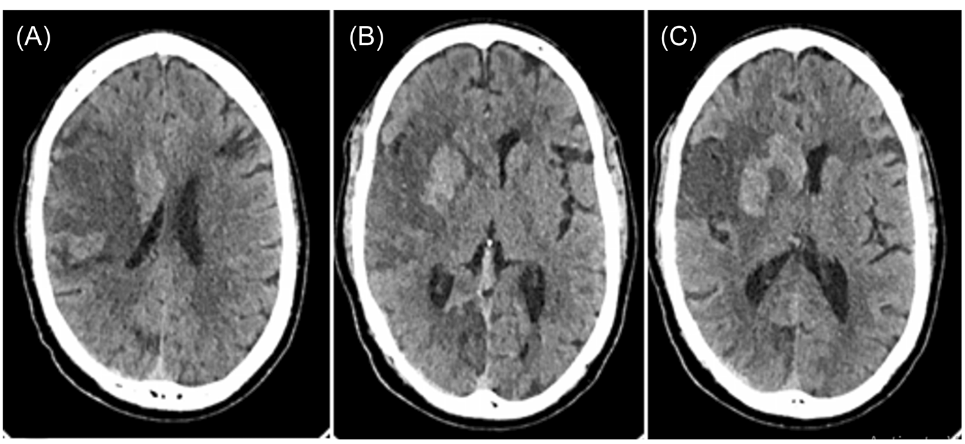

FIGURE 3 (A–C) axial NCCT of a 55-year-old male, hypertensive with left-sided hemiplegia, confusion for 3 days. Axial brain NCCT showing a geographical hypodense lesion in the territory of the right MCA indicative of an acute ischemic stroke. MCA, middle cerebral artery; NCCT, noncontrasted computerized tomography.

a study by Hamdy and colleagues in Egypt reported more right-sided strokes compared to the left. The reasons for the difference are unclear but probably related to the study design.[39]

This study also observed that stroke mostly occurred in the MCA vascular territory while the least was the ACA vascular territory. The preponderant involvement of the MCA is attributed to its relatively wide caliber and the direct continuity of the MCA with the internal carotid artery makes it more susceptible to direct transmission of thrombus. The findings here show good congruence with what others have reported.[40] This study also found that most of the patients had an ASPECTS of less than seven (<7) which was associated with a poor clinical outcome. Similar studies recorded similar findings with a mean ASPECTS score of 7.1, (95% CI 6.8–7.4).[41]

The most prevalent early ischemic change was loss of gray-white matter differentiation followed by sulcial effacement and basal ganglia hypodensity. This is aligned with the findings reported on early MCA infarction on CT, which revealed that effacement of cortical sulci and loss of gray-white matter interface were frequent in acute and hyper acute infarction.[40,42]

Clinical signs of stroke were significantly associated with CT features of stroke ($p < 0.05$). This implies that a patient with these symptoms is likely to have a stroke on a CT scan. This is in agreement with other studies where motor function/paresis was very common among stroke patients.[43] A reduced level of consciousness was associated with ischemic stroke. Whereas loss of consciousness or coma was predominant among hemorrhagic stroke. However, in multivariate analysis this was not of statistical significance after adjusting for other factors.

At multivariate analysis, hypertension as a risk factor was found to exist in the majority of patients with stroke accounting for more than half of the patients. Age above 65 years was significantly associated with a risk of a worse ASPECT score of ≤7.

4.1 | Study limitations

The study involved patients with a clinical diagnosis of stroke referred for brain CT that might have introduced a selection bias. We minimized some of the selection bias in those with multiple scans, by only analyzing the initial CT findings at the time of diagnosis. The clinical findings were obtained from the medical records of the patients whereas the clinicians who make the diagnosis were not interviewed to assess what other characteristics they based on to make the diagnosis of stroke and this possibly introduced information bias.

4.2 | Strength of the study

The strength of the study lies in the fact that it was a multicenter study conducted in public, private, and private-not-for-profit facilities where there is a relatively good representation of all categories of patients from different social strata.

5 | CONCLUSION

One-third of patients with a clinical diagnosis of stroke had no CT features of stroke, and for those who had CT features of stroke it was mainly an ischemic stroke. The most commonly affected vascular territory was an MCA and the left side was the most affected. Sixty-five and above years of age was strongly associated with having the worst ASPECTS score. The clinical diagnosis of stroke is likely problematic because of other stroke mimics at presentation such as tumors. Therefore, a brain NCCT should be used as the primary imaging modality especially in a low-resource setting where there is no MRI or CT perfusion studies which is the standard diagnostic method for differentiating stroke types, planning patient management and treatment; and timely referral to a stroke center.

AUTHOR CONTRIBUTIONS

Mboizi Vincent: Conceptualization; investigation; methodology; resources; writing—original draft. **Senai Goitom Sereke**: Conceptualization; investigation; writing—original draft; writing—review & editing. **Rita Nassanga**: Methodology; supervision; validation; visualization; writing—review & editing. **Mukisa Robert**: Methodology; resources; supervision; validation; visualization; writing—review & editing. **Faith Ameda**: Investigation; methodology; supervision; validation; visualization; writing—review & editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data sets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

Written informed consent was obtained from all participants to participate in the study. Ethical approval was obtained from the Makerere University School of Medicine Research and Ethics committee (reference No #REC REF 2021-101) and administrative clearance was sought from the three hospitals. The study was also carried out following relevant guidelines and regulations according to the Helsinki declaration.

TRANSPARENCY STATEMENT

The lead author Mboizi Vincent affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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