ORIGINAL ARTICLE

Neuroimaging Patterns of Stroke in Adult Patients in North-Eastern, Nigeria

Umar UH[1], Farate A[1], Yunusa DM[2], Lawan MM[1], Goni MA[1], Ahmadu MS[1], Ahidjo A[1]

ABSTRACT

Background: Stroke is a major cause of morbidity and mortality worldwide and is worsening in sub-Saharan Africa. Neuroimaging plays a vital role in its confirmation and ruling out stroke mimics. Brain CT scan is the workhorse in the management of patients with acute stroke where time matters. **Method:** This was a retrospective cross-sectional study of patients with clinical stroke and confirmed on CT scans from January 2020 to December 2023 that were conducted at departments of Radiology, University of Maiduguri Teaching Hospital and State Specialist Hospital, Maiduguri, North-eastern Nigeria. Data were retrieved and recorded from the archives which included biodata and CT scan patterns (stroke subtype and site, vascular territory, and number of lesions). Data were analyzed using Statistical Package for Social Sciences version 26 (IBM, 2019, Illinois, USA). **Results:** A total of 328 patients of the study population were recorded, of which 187 patients (57%) were males and 141 (43%) were females. The age ranged from 20 - 98 years, with a mean age (± SD) of 59.1 ± 14.9 years and a male-to-female ratio of 1.3:1 and the majority of the patients (55%) were aged ≥ 60 years. Ischaemic stroke was seen in 245 patients (75%) and haemorrhagic stroke (HS) was seen in 83 patients (25%). The most frequent stroke subtype was ischaemic stroke in both male and female patients. The relationship between the stroke subtype and age group was statistically significant (p=0.0001). Ischaemic stroke was the most observed subtype in all age groups than HS. Lobar location in particular the parietal lobe was the most commonly involved site in this study. The commonest vascular territory was the middle cerebral artery and the majority of stroke cases (88%) were solitary lesions. **Conclusion**: Neuroimaging differentiates infarction from haemorrhage and guides the treatment of acute stroke patients. Ischaemic stroke was the most frequent subtype in all genders and age groups with lobar location accounting for most stroke sites in this study. Non-contrast brain CT scan is the ideal imaging modality in the management of acute stroke.

Keywords: Stroke, Brain CT, Subtype, Site, Vascular Territory

[1]Department of Radiology, College of Medical Sciences, University of Maiduguri, Maiduguri, Borno State, Nigeria. [2]Department of Radiology, College of Medical Sciences, Modibbo Adama University, Yola, Adamawa State, Nigeria.

Corresponding Author:

Dr Umar Hassan Umar
Department of Radiology, College of Medical Sciences, University of Maiduguri, PMB 1069, Maiduguri, Borno State, Nigeria. Phone no.: +2348037614515, E-mail: umarhub@gmail.com

Date Submitted 20th August 2024
Date Accepted 23th December 2024

Access this article online

QuickResponse Code

website:www.bornomedicaljournal.com

DOI: 10.31173/bomj.bomj_2432_21

Introduction

Stroke also known as cerebrovascular disease or accident is a focal injury of the central nervous system (CNS) by a vascular cause and is a major cause of morbidity and mortality worldwide[1]. The burden of stroke worldwide has increased substantially with the bulk of the global burden residing in lower-middle income countries including Nigeria[2,3]. The overall crude prevalence of stroke in urban Nigeria was 1.14/1,000 with a tendency of increasing prevalence with advancing age[2]. In sub-Saharan Africa, stroke shows a worse prognosis and is mostly seen in younger ages[4]. Large geographical differences in age-standardized stroke incidence, prevalence and mortality were reported in previous studies and there was more absolute number of strokes in males than females at the global level[3].

Stroke is generally divided into ischaemic stroke and haemorrhagic stroke (HS). Haemorrhagic stroke is further subdivided into intracerebral haemorrhage (ICH) and subarachnoid haemorrhage (SAH). Ischaemic stroke is usually related to arterial thrombosis, embolization or critical hypoperfusion which leads to vessel occlusion while haemorrhagic stroke is commonly due to the spontaneous rupture of blood vessels within the brain and ultimately results in brain cell injury which affects focal brain function[5,6]. The main evidence of stroke may be based on neuroimaging, pathology and/or persistent neurological features[1,5].

Neuroimaging investigations employed in the evaluation of patients with acute stroke include non-contrast brain computed tomography (CT) scan, CT perfusion, CT angiography and magnetic resonance imaging (MRI)[5,6]. Advances in neuroimaging have enhanced the understanding of ischaemia, infarction and haemorrhage in the CNS and also knowledge of vascular anatomy is paramount for the clinical diagnosis of stroke with brain injuries related to vascular causes usually focal ones[1]. Neuroimaging studies are aimed to evaluate acute stroke with regards to its subtypes (infarction or haemorrhage), rule out non-vascular stroke mimics like intracranial tumours or subdural haematoma and also assess the size, site and extent of the lesions[1,5]. CT scan is a mainstay imaging modality which is more readily available, fast and affordable than MRI, and is usually able to exclude stroke mimics and differentiate between brain infarction/ischaemia and haemorrhage[1,5]. Non-contrast CT of the brain is the first and immediate imaging modality that should be done on patients with acute stroke and it is highly sensitive in the identification of haemorrhagic lesions[6]. Previous studies in African countries showed some stroke cases had neuroimaging for confirmation while other cases did not because of its non-availability and/or unaffordability[4].

Previous studies showed ischaemic stroke as the most common subtype of stroke in Nigeria[7-13] and other sub-Saharan African countries[14,15], and also parietal lobe was the most common stroke site involved in their independent studies[7-9,11-13,16,17]. The middle cerebral artery (MCA) was the commonest vascular territory involved in stroke patients[9,14,17,18]. Knowledge of brain arterial vascular territory plays a crucial role in understanding stroke and its complications from endovascular procedures and surgery[19].

This study aims to determine the neuroimaging patterns of stroke in adult patients in Maiduguri, North-eastern Nigeria. To the best of our knowledge, there is a paucity of literature on this topic, especially on the stroke site, the number of lesions and vascular territory in this environment which prompted this study

Methods

This was a retrospective hospital-based cross-sectional study of patients referred to the Department of Radiology, University of Maiduguri Teaching Hospital (UMTH) and State Specialist Hospital (SSH), Maiduguri, North-eastern Nigeria for CT scan with clinical features of stroke from January 2020 - December 2023. The two hospitals are tertiary healthcare referral centres for people in Borno state and its neighbouring states and countries. Ethical approval for the study was obtained from the research and ethical committee of the institutions. Inclusion criteria were all patients with a clinical diagnosis of stroke and confirmed on brain CT scan and aged 18 years and above. The exclusion criteria were clinical stroke patients in which a CT scan was to rule out stroke, patients with recurrent stroke, and patients who presented with clinical features of stroke of more than two weeks (because of the low sensitivity and specificity of CT in differentiating the subtypes) and patients below 18 years of age. All brain CT scans were acquired on a 128-slice Seimens CT Scanner or a 64-slice Acquilon Canon CT Scanner at UMTH, Maiduguri and a 128-slice General Electric CT scanner at SSH, Maiduguri. Non-contrast axial images of the brain were obtained from the base of the skull to the vertex at 3.5 mm slice thickness. Images were then reformatted at thinner slice thickness for coronal and sagittal planes. Data were retrieved from medical records and CT image archives of the institutions. All the CT images were reported by experienced Radiologists. Information including the patient's age, sex, stroke subtype, site, involved vascular territory, and the number of lesions were recorded in the datasheet. Ischaemic stroke is seen as a hypodense lesion involving an area of brain parenchyma (Figure 1) while HS is seen as a hyperdense lesion with perilesional oedema (Figure 2). Data were analyzed using Statistical Package for Social Sciences (SPSS) version

26 (IBM, 2019, Illinois, USA) for Windows®. Results were presented in tables, percentages, ratios and mean ± standard deviation (SD). Chi-squared or Fisher's exact test was used to determine the relationship between the categorical variables and the p-value of less than or equal to 0.05 was considered statistically significant.

Figure 1: Axial non-contrast brain CT scan image at the level of body of lateral ventricles showing a hypodense lesion (Star) at the left parieto-occipital lobe which compresses the body of lateral ventricles and midline shift to contralateral side and effacement of adjacent sulci and gyri which represents cerebral infarct.

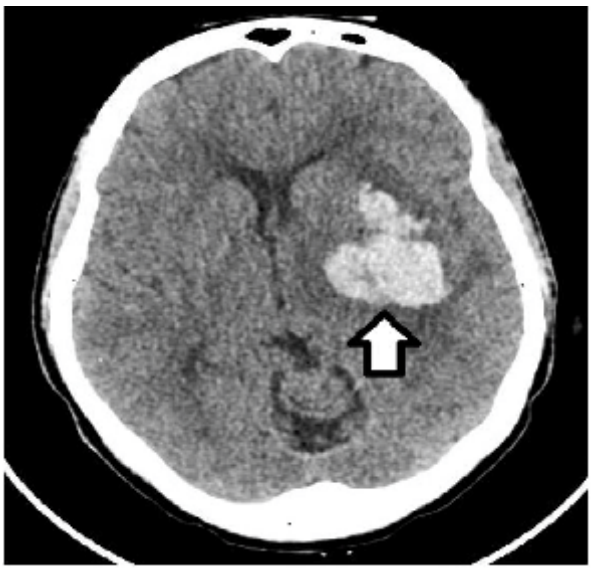

Figure 2: Axial non-contrast brain CT scan image at the level of the frontal horn of lateral ventricle showing a well-defined hyperdense lesion (Arrow) with surrounding perilesional oedema at the left lentiform nucleus, thalamus, and internal capsule and compress ipsilateral frontal horn of lateral ventricle which represents intracerebral haemorrhage.

Results

A total of 328 patients with a clinical diagnosis of stroke and confirmed on brain CT scan were recorded for this study, of which 187 patients (57%) were males and 141 (43%) were females. The study population age range was 20 to 98 years with a mean age (± SD) of 59.1 ± 14.9 years and a male-to-female ratio of 1.3:1. The age and sex distribution of the study population was as shown in Table 1. The Table also showed that the most involved age group was patients aged ≥ 60 years in both males and females, which accounted for 55.2% of the study population. Then, followed by patients aged 40 - 59 years. The relationship between age and sex of the study population was not statistically significant ($p = 0.073$).

Table 2 shows the distribution of stroke subtypes with the sex of the patients. Ischaemic stroke was observed in 245 patients (74.7%) and HS was seen in the remaining 83 patients (25.3%). Among the HS cases, 78 (23.8%) were intracerebral haemorrhage and the remaining 5 patients (1.5%) had SAH. In all subtypes of stroke, males were more affected than females as shown in Table 2, but females were more affected with SAH than male patients in this study. The relationship between stroke subtypes and sex was not statistically significant ($p = 0.442$).

Table 3 shows the relationship between stroke subtypes and age groups of patients. It showed that ischaemic stroke was the most frequent stroke subtype in all age groups. The relationship between the age group and stroke subtype of the study population was statistically significant ($p = 0.0001$).

The relationship between the stroke site and subtype is shown in Table 4. The most common stroke site was a lobar location in the study population, which accounted for 207 cases (63.2%), and then followed by basal ganglia in 54 cases (16.4%). Of the lobar lesions, the parietal lobe was the most common site which accounted for 86 cases (26% of all patients) and is immediately followed by the frontoparietal lobe in 57 patients (17.4%). The lobar lesion was also the

most frequent site in ischaemic stroke and HS. The relationship between stroke sites and subtypes of the study population was statistically significant (p = 0.0001).

Table 5 shows that the most commo n vascular territory of ischaemic and haemorrhagic stroke in this study was the MCA territory, which accounted for 185 patients (56.4%). Then, immediately followed by the multiple territorial involvement of both middle and anterior cerebral arteries, which was seen in 38 cases (11.6%) The relationship between the vascular territory and stroke subtype was statistically significant (p = 0.0001). The anterior circulation was the most common territory, which was recorded in 255 patients (77.7%), then, followed by posterior circulation which accounted for 53 cases (16.2%) and the remaining 20 patients (6.1%) had both circulations.

Most of the patients in the study had solitary lesions, which accounted for 288 patients (87.8%) while the remaining 40 (12.2%) had multiple lesions. In all patients with ischaemic stroke, only 9 cases (3.7%) had a haemorrhagic transformation. While, in patients with ICH, 19 (24.4%) had coexisting intraventricular haemorrhage.

Table 1: Age and Sex Distribution of the Study Population

	Sex Frequency (%)		
Age group (years)	Male	Female	Total
18 - 39	13 (4.0)	18 (5.5)	31 (9.5)
40 - 59	62 (18.9)	54 (16.5)	116 (35.4)
≥ 60	112 (34.1)	69 (21.0)	181 (55.2)
Total	187 (57.0)	69 (21.0)	328 (100.0)

P = 0.073

Table 2: Distribution of Stroke Subtypes and Sex

	Sex Frequency (%)		
Stroke Subtype	Male	Female	Total
Ischaemic	143 (43.6)	102 (31.1)	245 (74.7)
Haemorrhagic	44 (13.4)	39 (11.9)	83 (25.3)
ICH	*42 (12.8)*	*36 (11.0)*	*78 (23.8)*
SAH	*2 (0.6)*	*3 (0.6)*	*5 (1.5)*
Total	187 (57.0)	141 (43.0)	328 (100.0)

P = 0.442, ICH - Intracerebral Haemorrhage, SAH - Subarachnoid Haemorrhage

NB. ICH & SAH are subtypes of haemorrhagic stroke

Table 3: Distribution of Stroke Subtypes and Age Group

	Stroke Subtype Frequency (%)		
Age Group (years)	Ischaemic	Haemorrhagic	Total
18 - 39	19 (5.8)	12 (3.7)	31 (9.5)
40 - 59	74 (22.6)	42 (12.8)	83 (25.3)
≥ 60	152 (46.3)	29 (8.8)	181 (55.2)
Total	245 (74.5)	83 (25.3)	328 (100.0)

P = 0.0001

Table 4: Distribution of Stroke Sites and Subtypes

	Stroke Subtype Frequency (%)		
Stroke Site	Ischaemic	Haemorrhagic	Total
Lobar	174 (53.1)	33 (10.1)	207 (63.2)
Basal Ganglia	27 (8.2)	27 (18.2)	54 (16.4)
Thalamus	18 (5.5)	9 (2.7)	27 (8.2)
Pons	9 (2.7)	1 (0.3)	10 (3.0)
Midbrain	2 (0.6)	0 (0.0)	2 (0.6)
Cerebellum	5 (1.5)	1 (0.3)	6 (1.8)
Subarachnoid	0 (0.0)	5 (1.5)	5 (1.5)
Others	2 (0.6)	3 (0.6)	5 (1.5)
Total	245 (74.7)	83 (25.3)	328 (100.0)

P = 0.0001

Table 5: Distribution of Vascular Territory and Stroke Subtypes

	Stroke Subtype Frequency (%)		
Vascular Territory	Ischaemic	Haemorrhagic	Total
MCA	155 (59.5)	60 (9.1)	185 (56.4)
MCA & ACA	20 (6.1)	18 (5.5)	38 (11.6)
ACA	19 (7.8)	12 (3.7)	31 (9.5)
PCA	17 (5.2)	12 (3.7)	29 (8.8)
VBA	18 (5.5)	4 (1.2)	22 (6.7)
Others	16 (4.9)	7 (2.1)	23 (7.0)
Total	245 (74.7)	83 (25.3)	328 (100.0)

P = 0.0001, MCA = Middle Cerebral Artery, ACA = Anterior Cerebral Artery, PCA = Posterior Cerebral Artery, VBA = Vertebrobasilar Artery

Discussion

Stroke is a major cause of disability and death in adults worldwide with increasing rates in sub-Saharan Africa including Nigeria. A CT scan confirms the diagnosis of stroke and also differentiates infarction from haemorrhage which is crucial in the treatment of acute stroke. Previous studies showed a low degree of accuracy in clinical diagnosis of acute stroke and differentiating its subtypes in Nigeria[10,20-23], and other countries[15,24]. Clinical diagnosis of stroke can be used only when neuroimaging is not available[25]. In this study, the mean age of the patients was 59 years which was almost in agreement with most previous studies in Nigeria[8,11,12,17,22,26,27], and other countries[14,28]. However, it differed from the findings of other studies by Yunusa GH *et al*[9] and Ijeh *et al*[29] who observed it in more younger individuals, aged 49 - 55 years and while, it was noted in older patients aged 60 – 65 years by Baduku *et al*[27] and Al-Rajeh *et al*[30] in their respective studies.

In the index study, the majority of patients (55.2%) were elderly (aged ≥60 years), and similar findings were observed in previous studies[11,17,26-28,30-32]. Danesi *et al*[2] did an urban community-based study in Lagos, South-western Nigeria which showed an increasing prevalence of stroke with advancing age. However, other studies[7,8,10,12,14,15,29,33] reported more cases in middle-aged patients (40 - 59 years) which differed from this index study. Many studies showed that stroke in blacks affects more younger individuals than older ones which might be due to a low life span in Africa [4].

Male preponderance was also observed in this study which was in concordance with most previous studies in Nigeria[7,8,10,11,16,17,22,25,27,29,31], other sub-Saharan African countries[15,28,32], and some Asian countries[24,33,34,34] but it disagreed with other studies in Nigeria by Taiwo *et al*[12], Bello *et al*[18] and Onubiyi *et al*[22] who showed female preponderance. Male sex is a known non-modifiable risk factor of stroke, which is also associated with other risk factors like hypertension and diabetes mellitus which are usually poorly controlled diseases, especially in developing countries.

On CT scan finding in our study, ischaemic stroke was reported in 75% of patients, this is in concordance with some studies that showed values ranged from 70% to 92% in Nigeria[7,17,26,27], other sub-Saharan African countries[15,28,32] and some Asian countries[24,30,34] which almost agreed with this index study and was commonly observed values in high-income countries. While other studies in Nigeria[9-13,16,18,22,29] and other countries[14,24] reported lower values ranging from 52% to 69%, this finding was commonly observed in many studies in low and middle-income countries. Matuja *et al*[35] in Tanzania and Oyinloye *et al*[36] in North-central Nigeria reported less than 50% of cases of ischaemic stroke, which also

disagreed with the index study. However, a study on stroke by Oyinloye *et al*[36] was on young adults while our study was on all adults, which might explain the disagreement.

Also HS, mainly ICH was seen in 25.3% of the patients which was almost similar to many previous studies in Nigeria[7,8,10,11,17,27,37] and other countries[15,24,28] who obtained a low proportion of HS ranging from 7% to 29%. This might be explained that patients in sub-Saharan African countries have a higher mortality rate from HS and also due to various delays encountered by patients in obtaining appropriate healthcare services. Some studies in Nigeria[12,16,18,22,26,29,31] and other countries[14,33,34] obtained higher values of HS which range from 30% to 49%. Africans have a relatively high proportion of HS compared to high-income countries with an average of 20%. Also, Matuja *et al*[35] and Oyinloye *et al*[36] reported values of more than 50% in their respective studies in patients with HS, which also differed from our finding.

SAH was observed in this study in 1.5% of the patients and this was in agreement with previous studies[8,9,15,22,29,30,34]. This low value might be due to poor accessibility to hospitals and poverty, as most of the patients die before reaching the hospital or accessing neuroimaging for diagnosis. However, Annongo *et al*[31] and Desita *et al*[33] in their respective studies in Nigeria obtained higher values of 4.1% and 8.5% which was in disagreement with this index study. However, some studies especially in Africa on neuroimaging of stroke did not subclassify HS into ICH and SAH [10,12,16,18,22,35].

This study showed that ischaemic stroke was the most frequent stroke subtype in all age groups and this was in agreement with some previous studies[10,11,20,22,26], and other African countries[15,28]. Male patients were most frequently affected in both ischaemic haemorrhage and HS. This was in concordance with previous studies in Nigeria[7,9,10,13,18,26], and other countries[30,32,34,35].

Desita *et al*[33] observed that more females than males were affected with HS but more males than females with an ischaemic stroke which partly disagreed with this index study. Onubiyi *et al*[22] observed more females than males had ischaemic stroke but more males compared to females had HS which also partly disagreed with this index study.

Lobar location was the most frequent site seen in 63% of this study population and also in patients with ischaemic stroke and HS which was similar to previous studies[7,8,15,18,33]. The parietal lobe was the common lobe involved in patients with ischaemic stroke and HS in this study which accounted for 26% of all cases and this agreed with many previous studies[11,12,16,17], while Ijeh-Taliha *et al*[29] recorded that the parietal lobe was the most common location in ischaemic stroke while basal ganglia was the commonest site in patients with HS, and partly differed from our finding. Edzie *et al*[26], Chhetri *et al*[34], and Oyinloye *et al*[36] in their respective studies showed that the basal ganglia was the most frequent site in patients with both ischaemic stroke and HS in their study. Oyinloye *et al*[36] did a study on young adult stroke patients which might be the reason but this study was on all adult patients. In HS cases in the index study, if basal ganglia and thalamic locations were considered as an entity (thalamo-ganglionic location), it accounted for the most frequent site which comprised of 20.9% of all patients which was two times higher than lobar. This was in agreement with a study by Yunusa *et al*[8] in Gombe, North-eastern Nigeria.

The MCA was most frequently involved vascular territory in this study which accounted for 56.4% and this was in concordance with many previous studies in Nigeria[8,17,18,26] and other countries[14,15,34]. This might explain that the MCA is the largest artery and direct continuation of the internal carotid artery that supplies its significant parts and mainly arterial supply of the parietal lobe, the most involved site in this study.

Most of the lesions in this study were solitary ones, which accounted for 88% of cases and the remaining 12% had multiple sites. It was in concordance with some studies[26,28,33]. However, Taiwo *et al*[12] and Adamu *et al*[17] in Northern Nigeria in their independent studies showed higher values of multiple lesions of stroke of 44% and 57% respectively which differed from this index study. This proportion could be due to failure to differentiate a solitary lesion with multiple involved parts of the brain and multifocal lesions of stroke by the authors.

In this study, ischaemic stroke with haemorrhagic transformation was seen in 3.7% of the patients and this finding was similar to that of Khan *et al*[24] but it differed from independent studies by Bello *et al*[18] in Nigeria and Desita *et al*[33] in Ethiopia who obtained low values of less than 1.6%. Haemorrhagic

transformation is a complication of ischaemic stroke and can significantly worsen its prognosis.

Conclusion

Stroke is a common neurological condition in Nigeria and worldwide and a CT is a good imaging modality for its diagnosis and differentiating its subtypes which is critical in the management of stroke patients. Ischemic stroke was the most common subtype in all genders and age groups in this study. Lobar location, in particular the parietal lobe, was the most frequent site involved and the middle cerebral artery was the most affected vascular territory in this index study. Most of the stroke lesions were solitary ones in the index study. Non-contrast brain CT scan should be a mainstay imaging modality to evaluate acute stroke patients in low-resource settings including Nigeria.

Conflict of Interest: Nil

Financial support: Nil

Acknowledgement: We acknowledged the staff of the Radiology Departments of the University of Maiduguri Teaching Hospital and State Specialist Hospital, Maiduguri for their support during this study.

Authors' Contribution: All authors contributed considerably at various stages of writing this manuscript.

References

1. Sacco RL, Kasner SE, Broderick JP, Caplan LR, Connors JJ, Culebras A, *et al*. An updated definition of stroke for the 21st century: A statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2013; 44: 2064-2089.
2. Danesi M, Okubadejo N, Ojini F. Prevalence of stroke in an urban, mixed-income community in Lagos, Nigeria. Neuro-epidemiology 2007; 28: 216-223.
3. Feigin VL, Norrving B, Mensah GA. Global Burden of Stroke. Circ Res 2017; 120: 439-448.
4. Owolabi M, Olowoyo P, Popoola F, Lackland D, Jenkins C, Arulogun O, *et al.* The epidemiology of stroke in Africa: A systematic review of existing methods and new approaches. J Clin Hypertens. 2018; 20: 47–55. DOI: https://doi.org/10.1111/jch.13152.
5. Gaillard F, Sharma R, Cau B, *et al*. Ischaemic stroke. Reference Article, Radiopaedia.org (Accessed on 30 July 2024). DOI: https//doi.org/10.53347//rid-13437.
6. De Lucas EM, Sánchez E, Gutiérrez A, Mandly AG, Eva Ruiz E, Flórez AF, *et al*. CT Protocol for Acute Stroke: Tips and Tricks for General Radiologists. Radiographics 2008; 28(6): 1-10. DOI: http://dx.doi.org/10.1148/rg.286085502
7. Ikpeme AA, Bassey DE, Oku AO, Ephraim PE. Computerized tomography findings of cerebrovascular disease in adults in Calabar, Nigeria. West Afr J Radiol 2014; 21(1): 12-16.
8. Yunusa DM, Umar UH, Dahiru AMC, Usman AU, Sa'ad ST, Ibinaiye PO, *et al*. Computed tomographic pattern of stroke among adult patients in North-eastern Nigeria. Pyramid Journal of Medicine 2021; 4: 50.
9. Yunusa GH, Saidu SA, Ma'aji SM, Danfulani M. Pattern of computerized tomography of the brain findings in stroke patients in Sokoto, Northwestern Nigeria. Ann Afr Med 2014; 13: 217-220.
10. Eze CU, Okaro AO, Ohagwu CC. Pattern of computed tomography findings in cerebrovascular accident patients in South-eastern Nigeria - a retrospective study of 480 patients. Eur J Sci Res 2009; 34: 104-109.
11. Abdullahi MZ, Mohammad HM, Lawal S, Ibrahim MZ, Bello N, Aliyu I, *et al*. Evaluation of pattern of lesions depicted on brain computed tomography scan of patients presenting with stroke in Zaria, Nigeria. J West Afr Coll Surg 2023; 13: 16-21.
12. Taiwo YF, Igoh EO, Ani CC, Pam SD, Yakubu K, Taiwo FO. Acute stroke in Jos University Teaching Hospital: Cranial computed tomographic findings and accuracy of the clinical diagnosis. Sahel Med J 2019; 22: 71-76.
13. Kolade-Yunusa HO, Yaro IA, Yusuf L. Cranial computed tomography imaging of patients with stroke in a tertiary facility. West Afr J Radiol 2020; 27: 46-51.
14. Daffue K, Joubert G, Otto S. Computed tomography stroke findings and population demographics at Pelonomi Hospital, Bloemfontein. S Afr J Rad 2016; 20(1): a993. DOI: http://dx.doi.org/10.4102/sajr.v20i1.993.
15. Vincent M, Sereke SG, Nassanga R, Robert M, Ameda F. Correlation between clinical and brain computed tomography findings of stroke

patients: a cross-sectional study. Health Sci Rep 2023; 6: e1248. Doi: 10.1002/hsr2.1248.

16. Ogunseyinde AO, Atalabi OM. Cranial computerized tomography in the evaluation of stroke in Ibadan. Niger J Clin Pract 2003; 6: 81-83.

17. Adamu MY, Naimatu AT, Isyaku K, Idris SK, Lawal Y. Computed tomographic pattern of stroke among hypertensive and diabetic patients in Kano, Nigeria. J Radiat Med Trop 2021; 2: 24-30.

18. Bello TO, Aremu AA, Mustapha AF, Olugbenga-Bello AI. Cranial computerised tomographic assessment of cerebrovascular disease in Osogbo, Nigeria. West Afr J Med 2010; 29: 323-326.

19. D'Souza D, O'Shea P, Smith D, *et al*. Brain arterial vascular territories. Reference article, Radiopedia.org (Accessed on 30 July 2024). Https://doi.org/10.53347/rid-1085.

20. Luntsi G, Pindiga BY, Ahmadu MS, Nwobi IC, Eze CU, Aminu UU, *et al*. Evaluation of Pattern of Lesions Depicted on Brain Computed Tomography of Patients Presenting with Stroke in a Tertiary Hospital in Northern Nigeria. International Journal of Advanced Research 2015; 3(5): 1216-1222.

21. Onwuekwe IK, Ezeala-Adikaibe BA, Ohaegbulam SC, Chikani MC, Amuta J, Uloh HN. Stroke mimics - A study of CT images in Nigerian African stroke patients. Journal of Neurological Sciences [Turkish] 2008; 25(3); 148-154.

22. Onubiyi CCB, Nwankwo NC, Onwuchekwa RC, Ray-Offor OD, Eweputanna LI. Computerized tomography and clinical correlation of stroke diagnosis in University of Port Harcourt Teaching Hospital. Journal of Medicine and Medical Sciences 2015; 6(5): 90-94.

23. Ogun SA, Oluwole SO, Oluremi A, Fatade AO, Ojini F, Odusote KA. Accuracy of the Siriraj stroke score in differentiating cerebral haemorrhage and infarction in African Nigerians. Afr J Neurol Sci 2001; 20: 21-26.

24. Khan J, Rehman A. Comparison of clinical diagnosis and computerized tomography in ascertaining type of stroke. J Ayub Med Coll Abbottabad 2005; 17: 65-67.

25. Nyandaiti YW, Bwala SA. Validation study of the Siriraj stroke score in North-east Nigeria. Nigerian Journal of Clinical Practice 2008; 11(3): 176-180.

26. Akintomide AO, Efanga SA, Ngaji AI, Ozomma SI. Evaluation of the computed tomograms of stroke patients in a teaching hospital in Nigeria. Journal of Medicine in Africa 2023; 6: 1-7.

27. Baduku TS, Yusuf A, Thompson M. Stroke in Babcock University Teaching Hospital, Nigeria: a two-year retrospective study of CT imaging findings. Bo Med J 2022; 19(2): 128-135.

28. Edzie E K, Dzefi-Tettey K, Gorleku P, Amankwa AT, Idon E, Brakohiapa EE, et al. Evaluation of the anatomical locations of stroke events from computed tomography scan examinations in a tertiary facility in Ghana. Cureus 13(3): e14097. DOI: 10.7759/cureus.14097.

29. Ijeh-Tarila KI, Alaizgha N, Mbaba AN, Ogolodom MP, Orupabo-Oyan B, Nwazor E, *et al*. Brain Computed Tomography Findings in Stroke Patients in Port Harcourt: A Retrospective Hospital-Based Study. American Journal of Biomedical Science & Research 2020, 8(4): AJBSR.MS.ID.001286. DOI: 10.34297/AJBSR.2020.08.001286.

30. Al-Rajeh S, Awada A, Niazi G, Larbi E. Stroke in a Saudi Arabian National Guard community: Analysis of 500 consecutive cases from a population-based Hospital. Stroke 1993; 24(11): 1635-1639.

31. Annongu IT, Iwuozo EU, Hameed MO, Chia DM, Mohammed SS, Mbahon FA. Clinical and Brain Computed Tomographic Profile of Stroke Patients in a Tertiary Hospital, North Central Nigeria. World Journal of Neuroscience, 2022, 12, 187-202. DOI: 10.4236/wjns.2022.124020.

32. Sagui E, M'Baye PS, Dubecq C, Fall KB, Niang A, Gning S, *et al*. Ischemic and Haemorrhagic Strokes in Dakar, Senegal: A Hospital-Based Study. Stroke 2005; 36: 1844-1847.

33. Desita ZT, Zewdu WM. CT scan patterns of stroke at the University of Gondar Hospital, North-West Ethiopia. British Journal of Medicine & Medical Research 2015; 6(9): 882-888.

34. Chhetri PK, Raut S. Computed tomography scan in the evaluation of patients with stroke. Journal of College of Medical Sciences-Nepal 2012; 8(2): 24-31.

35. Matuja W, Janabi M, Kazema R, Mashuke D. Stroke subtypes in black Tanzanians: a retrospective study of computerised tomography scan diagnosed at Muhimbili National Hospital, Dar es Salaam. Trop Doc 2004; 34: 144-146.

36. Oyinloye O, Nzeh D, Adesiyun O, Ibrahim M, Akande H, Sanya E, *et al*. Neuroimaging of young adults with stroke in Ilorin Nigeria. Ann Afr Med 2015; 14: 82-88.

37. Yunusa DM, Umar UH, Dahiru AM, Aminu UU, Suleiman TS, Ibinaiye PO, *et al.* The value of cross-sectional imaging in evaluation of stroke patients. J Radiat Med Trop 2020; 2: 36-39.

Cite this Article as: Umar UH, Farate A, Yunusa DM, Lawan MM, Goni MA, Ahmadu MS, Ahidjo A. Neuroimaging Patterns of Stroke in Adult Patients in North-Eastern, Nigeria. **Bo Med J** 2024; 21 (2):205-214
Source of Support: Nil, **Conflict of Interest**: None declared