ORIGINAL ARTICLE

BRAIN COMPUTED TOMOGRAPHIC FINDINGS OF STROKE PATIENTS IN MAIDUGURI, NORTH-EASTERN NIGERIA

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ABSTRACT

Background: Stroke is a major neurological condition with high disability and mortality rates in developing countries including Nigeria. Computed tomography (CT) scan is an important imaging modality in confirming the diagnosis of stroke, classifying stroke subtypes and ruling out stroke mimics. **Objectives:** To determine the CT findings of patients with stroke in Maiduguri, North-eastern Nigeria. **Methodology:** A retrospective hospital-based study conducted at the Department of Radiology, Federal Neuro-psychiatric Hospital, Maiduguri, North-eastern Nigeria over four-year period from January 2015 to December 2018. All patients were clinically diagnosed with stroke and referred to the department for a brain CT scan. The request forms and CT reports were retrieved from the Archive and analysed. All patients were examined with a 16-slice General Electric CT scanner. Data were analysed using SPSS statistical software version 23. **Results:** There were 138 patients and out of which, 83 (60%) were males and 55 (40%) females with a male to female ratio of 1.5:1. The mean age was 51.6 ± 16.6 years with an age range of 5-85 years and the majority of the patients were middle-aged group. The CT findings showed 88 (64%) were confirmed stroke cases and the remaining 50 (36%) were misdiagnoses of stroke, with normal finding in 23% and stroke mimics in the remaining 13%. Brain infarction was the most common stroke subtype accounting for 64% of the patients, followed by intracerebral haemorrhage of 33% and 3% had subarachnoid haemorrhage. The left cerebral hemisphere was the most commonly involved. Cerebral atrophy and brain tumours were the two most common stroke mimics in this study and they were mostly seen in females than males. **Conclusion**: In this study, the accuracy rate of clinical diagnosis of stroke was low. Therefore, CT scan is the 'gold standard' in the diagnosis of stroke and it is strongly recommended in the management of all stroke patients.

Key words: *Computed Tomography, Maiduguri, Stroke, Stroke Mimic, Stroke Side, Stroke Subtype*

INTRODUCTION

Stroke, also known as cerebrovascular disease (CVD), is the second leading cause of death after ischaemic heart disease and the third leading cause of disability, Worldwide.[1,2] It is mainly characterized as a focal neurological deficit of the central nervous system (CNS) of vascular cause, including brain infarction (BI), intracerebral haemorrhage (ICH) and subarachnoid haemorrhage (SAH).[3] In contrast to the declining stroke rates in most developed countries, the incidence of stroke in Africa including Nigeria has risen over the last two decades and about 86% of all stroke deaths around the world are contributed by low- and middle-income countries in Africa and other developing countries.[4] From the global burden of diseases, stroke incidence appears to be

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increasing in Africa and the proportion of haemorrhagic stroke ranges from 29-57%, in comparison with 16-20% found in developed countries.[4] However, BI accounts for the majority of cases (about 80%) globally.[5] In several studies from the West African sub-region, stroke is the leading cause of adult neurological admissions, constituting up to 65%.[4] The crude prevalence rate of stroke in Nigeria was 1.14/1,000 population[6] and it was higher in males than females.[2] Previous community-based study in South-western Nigeria showed a trend of increasing prevalence with advancing age.[6]

Current guidelines for the management of acute stroke recommend a course of treatment based on the diagnosis of subtype of stroke (ischaemic or haemorrhagic) using neuro-imaging with computed tomography (CT) or magnetic resonance imaging (MRI). In some cities and villages in Nigeria, CT and MRI are not readily available or affordable, thus making clinicians make difficult clinical decisions, such as deciding which patient will benefit from anticoagulant therapy and to what level to control patients' blood pressure.[1,7] Computed tomography is relatively available and affordable than magnetic resonance imaging (MRI) and usually able to exclude stroke mimics like brain tumours, subdural haemorrhage (SDH) and abscess.[3] The duration of CT scanning is less compare to MRI, which should be considered in critically ill patients and then, brain CT scan is the first imaging modality employ in evaluating of patients with acute stroke, especially in the exclusion of haemorrhagic subtype.[7,8]

Previous studies in Maiduguri, North-eastern Nigeria on stroke in which validation of Siriraj stroke score and comparison of hospital stroke scores with CT scan findings were reviewed but confirmation of stroke mimics and differentiating ICH and SAH were not highlighted in these studies.[7,8,9] Salawu *et al*[8] in their study reported low sensitivity, specificity, positive predictive value and accuracy rate of clinical stroke scores in diagnosing stroke and confirming its types and they concluded that cross-sectional imaging is irreplaceable in the clinical management of patients with stroke.[8] Watila *et al*[10] in a study in Maiduguri reported that only a few (21%) of all stroke patients had neuroimaging (CT or MRI), where WHO criteria and Siriraj stroke score were mostly used for the diagnosis and differentiating stroke subtypes.[10] Similarly, in another study conducted in Kano, North-western Nigeria, only 39% of stroke patients had neuroimaging done.[11] Almost similar findings were reported in other studies in North-western,[12] South-western[13] and South-eastern[14] Nigeria. A similar trend was documented in other sub-Saharan African countries including Ghana,[15] Senegal[16] and Tanzania.[17] Some of the reasons for not doing neuroimaging in these studies were; non-availability, poverty and illiteracy. However, a study in North-Central Nigeria by Alkali *et al*[7] showed that most of the stroke patients (97%) had neuroimaging done.

Previous studies revealed that 2.5 to 34% of patients were misdiagnosed as having stroke based on clinical assessment and after performing brain CT scans, these patients either had normal neuroimaging findings or had stroke mimics.[5,18-25] However, Ogun *et al*[26] in South-western Nigeria reported as high as 43% of clinical misdiagnosis of stroke in their study. The accuracy rate of the clinical diagnosis of stroke was usually less than 85% (range 57-90%) as reported in many studies in Nigeria[5,8,20-26] and an almost similar finding was also reported in Pakistan, Asia.[27]

The BI is the most common subtype of stroke in most studies (ranging from 54% to 85%) from Northern[7-9,18,26,28] and Southern[5,14,20-25] Nigeria, and other Sub-Saharan African countries[15,16,29] and also some Asian countries.[27,30-32] The left cerebral hemisphere was the most common site affected in stroke patients in previous studies.[5,21] Most studies also showed that in all stroke subtypes, they were more common in males than females.[5,21,24,28,31,33] Brain atrophy and tumours were the two most common stroke mimics reported by previous researchers in Nigeria.[19,21,25,26] A study on stroke patients was reported from Gombe, North-eastern Nigeria but the parameters such as stroke side and mimics were not highlighted.[28]

To the best of our knowledge, there is a paucity of literature in Maiduguri and entire North-eastern Nigeria on brain CT findings in stroke, this prompted this study. This study aimed to determine the CT findings of patients with stroke in Maiduguri, North-eastern Nigeria.

MATERIALS AND METHOD

This was a four-year retrospective study of clinically diagnosed stroke patients that were referred for brain CT at the Radiology department of Federal Neuro-psychiatric Hospital, Maiduguri, North-eastern Nigeria from January 2015 to December 2018. The patients were mainly referred from Medical wards and Accident and Emergency units of the University of Maiduguri Teaching Hospital and State Specialist Hospital, Maiduguri, Nigeria and the remaining were from peripheral hospitals in Borno state and neighbouring Yobe state. All examinations were performed using a 16-slice CT scanner (General Electric, BrightSpeed® Waukesha, WI, USA). The request forms and CT reports were retrieved from the Archive and were reviewed. All patients (or care-givers of unconscious patients) gave informed consent before CT scan examination and ethical guidelines on medical research were followed. Relevant clinical information such as the age, sex, and clinical features and clinical diagnosis were obtained from the patients' request forms and the CT findings were obtained from CT scan reports. However, some patients were excluded from the study and the exclusion criteria include: those with recurrent stroke and those with stroke lasting for more than 15 days because of the problem of differentiating infarction and haemorrhage at that stage.[8]

The CT findings were categorized into: stroke, stroke mimic and normal. The stroke subtypes include BI, ICH and SAH and the stroke sides include left hemisphere, right hemisphere and bilateral. The stroke mimics (clinically misdiagnosed as stroke) include: intracranial (IC) tumours, subdural haemorrhage, IC infection, IC arteriovenous malformation (AVM) and cerebral atrophy. All CT scan examinations were reported by two experienced consultant Radiologists. Brain infarction is typically seen as a hypodense area in the cerebral hemisphere on the CT image (Figure 1), while ICH is seen as a hyperdense area in the cerebral hemisphere (Figure 2).

Data were processed and analysed using SPSS version 23 statistical software. Descriptive data were presented in mean (±standard deviation), range, ratio and percentages. Relationships between variables were evaluated using chi-square, Fisher's exact and Student t-tests. A confidence interval of 95% was used and a p-value of < 0.05 was considered statistically significant.

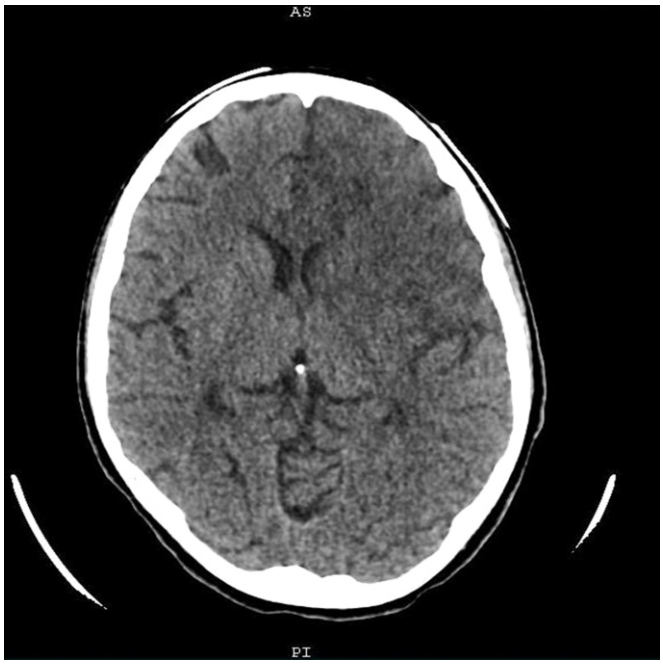

Figure 1: Axial non-contrast enhanced computed tomographic image showing hypodense area with loss of grey-white matter differentiation in the left fronto-parietal region and compression of adjacent frontal horn of left lateral ventricle representing acute cerebral infarction.

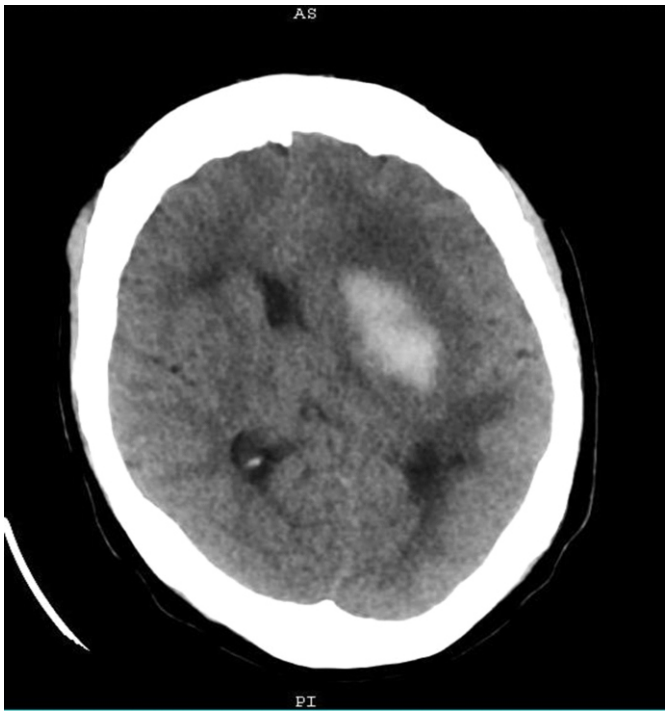

Figure 2: Axial non-contrast enhanced computed tomographic image showing a hyperdense area with surrounding area of hypodensity due to perilesional oedema at the region of left lenti-form nucleus and internal capsule with ipsilateral mass effect as evidenced by shifting of midline to the right and compression of left lateral ventricle representing acute intracerebral haemorrhage.

RESULTS

There were 138 stroke patients reviewed during the four-year study period. Of these, 83 (60%) were males and 55 (40%) were females with a male to female ratio of 1.5:1. The mean age was 51.6 (± 16.6) years with an age range of 5 to 85 years and almost half of the patients were in the age group of 41-60 years as shown in Table 1.

Table 2 shows the CT findings of the clinically diagnosed stroke patients, of which only 88 (64%) of the patients had confirmation of stroke on CT scan. The remaining 50 (36%) patients were clinical misdiagnoses of stroke (either stroke mimic or normal). It also showed males were more affected than females in the stroke patients which were confirmed on CT scan. However, there was no statistically significant difference in CT findings among the two sexes (p=0.30). Of the 88 patients with confirmed CVD, 56 (64%) had BI while the remaining 32 (36%) had a haemorrhagic stroke (including ICH and SAH) as shown in Table 3 and 55 (62%) patients were males and the remaining 33 (38%) were females. Also, there were more males than females in all stroke subtypes. However, their relationship was not statistically significant (p=0.68). Only 4 patients (5%) of the confirmed stroke patients were of paediatric age (< 18 years), in which, there were 3 cases of BI and a case of ICH. Thirteen (15%) of the patients were young adults (18-40 years of age) with 7 cases of BI, 4 cases of ICH and 2 cases of SAH.

Table 4 shows that the left cerebral hemisphere was the most commonly involved side, accounting for 50.6% of the stroke patients. The most common stroke mimic was cerebral atrophy, seen in 6 patients, and followed by IC tumours (including astrocytoma and meningioma) as shown in Table 5. The stroke mimics were commonly seen in female patients than male patients, however, the relationship was not statistically significant (p=4.23)

Table 1: The Age and Sex Distribution of the Study Population

Age Group (years)	Male (%)	Female (%)	Total (%)
1-10	2 (1.2)	1 (0.7)	3 (2.2)
11-20	4 (2.9)	0 (0.0)	4 (2.9)
21-30	4 (2.9)	4 (2.9)	8 (5.8)
31-40	10 (7.2)	7 (5.1)	17 (12.3)
41-50	20 (14.5)	13 (9.4)	33 (23.9)
51-60	21 (15.2)	14 (10.1)	35 (25.4)
61-70	15 (10.9)	8 (5.8)	23 (16.7)
71-80	3 (2.2)	7 (5.1)	10 (7.2)
81-90	4 (2.9)	1 (0.7)	5 (3.6)
Total	**83 (60.1)**	**55 (39.9)**	**138 (100)**

Table 2: CT Findings of the Study Population

	Sex Frequency		
CT Finding	**Male (%)**	**Female (%)**	**Total (%)**
Normal	20 (14.5)	12 (8.7)	32 (23.2)
Stroke	55 (39.9)	33 (23.9)	88 (63.8)
Stroke Mimic	8 (5.8)	10 (7.2)	18 (13.0)
Total	**83 (60.1)**	**55 (39.9)**	**138 (100)**

Table 3: Distribution of Stroke Subtypes with Sex

	Sex Frequency		
Stroke Subtype	**Male (%)**	**Female (%)**	**Total (%)**
Brain Infarction	36 (65)	20 (61)	56 (64)
Intracerebral Haemorrhage	17 (31)	12 (36)	29 (33)
Subarachnoid Haemorrhage	2 (4)	1 (3)	3 (3)
Total	**55 (100)**	**33 (100)**	**88 (100)**

Table 4: Distribution of Stroke Sides with Sex

	Sex Frequency		
Stroke Side	**Male (%)**	**Female (%)**	**Total (%)**
Left Hemisphere	26 (49.1)	17 (53.1)	43 (50.6)
Right Hemisphere	21 (39.6)	14 (43.8)	35 (41.2)
Bilateral	6 (11.3)	1 (3.1)	7 (8.2)
Total	**53 (100)**	**32 (100)**	**85 (100)**

Table 5: Distribution of Stroke Mimics with Sex

	Sex Frequency		
Stroke Mimic	**Male (%)**	**Female (%)**	**Total (%)**
Intracranial Tumour	3 (37.5)	1 (10.0)	4 (22.2)
Subdural Haemorrhage	1 (12.5)	1 (10.0)	2 (11.2)
Infection			
Intracerebral Abscess	1 (12.5)	2 (20.0)	3 (16.6)
Cerebritis	0 (0.0)	1 (10.0)	1 (5.6)
Toxoplasmosis	0 (0.0)	1 (10.0)	1 (5.6)
Arteriovenous Malformation	1 (12.5)	0 (0.0)	1 (5.6)
Cerebral Atrophy	2 (25.0)	4 (40.0)	6 (33.3)
Total	**8 (100)**	**10 (100)**	**18 (100)**

DISCUSSION

Stroke is a major neurological condition worldwide with high morbidity and mortality and its trend increases in developing countries recently. Computed tomography plays a vital role in confirming the diagnosis, differentiating stroke subtypes and ruling out stroke mimics. The management of stroke depends on its subtype. The mean age in the index study was 52 years and the majority were within in the 5th and 6th decades of their lives, which agreed with most studies[7,8,10,21,23-25] while, some authors reported mean age in 7th decade in their studies.[11,13,26,29] While, Yunusa *et al*[18] reported 5th decade in their study. In this study, there was male preponderance accounting for 60% of the study population giving the male to female ratio of 1.5:1. This is in agreement with most studies in Nigeria,[7,10,11,18,21,24,28] other sub-Saharan African countries,[16,33] and some Asian countries.[27,30-32] Male sex is a known non-modifiable risk factor of stroke which explain these findings. However, few authors reported the female preponderance in their studies in North-central Nigeria,[34] and South Africa.[29]

The index study showed that the accuracy rate of clinically diagnosed stroke as confirmed by brain CT scan of 64%. This is in agreement with previous studies where accuracy rate was reported ranging from 75-84% of in Northern[8] and Southern[5,20-26] Nigeria. A lower rate of stroke (less than 60%) was reported by few authors in South-western Nigeria[26] and Pakistan[27] and this differed from our finding. The remaining 36% of the patients had no CT findings of stroke which were either stroke mimics (differentials) or normal findings. These emphasized the importance of brain CT scan in the management of stroke patients and buttress the low accuracy rate of clinical diagnosis of stroke and stroke scores in differentiating its subtypes. Also, SAH was not considered as a stroke subtype in Hospital stroke scores.

In stroke patients confirmed with CT scan in index the study, 15% were young people (range 18-40 years). Almost similar finding was reported in a study in south-eastern Nigeria.[25] This is also similar to the finding of Hamad *et al*[32] in Qatar. However, Alkali *et al*[7] reported 41% of young stroke patients in their study conducted in Abuja, Nigeria which disagreed with our findings. The index study showed that 5% of stroke patients were found in the paediatric age group and they were sickle cell disease patients and this is in concordance with a previous study done in North-western Nigeria[18] which also showed sickle cell disease as the major risk factor of stroke in children.

Twenty-three percent of the patients had normal CT finding in this study which disagreed with previous studies in Nigeria with low values (range from 3.3% to 16%).[20,21,23-26,28] Normal finding of the clinically suspected stroke patients does not rule out early BI which has subtle changes and also small lacunar infarcts and brainstem lesions might be seen as normal. Therefore, MRI is recommended in early stage of stroke in patients with normal CT finding[3,21] In our study, 64% of the patients had BI which was the most common stroke subtype. This agreed with most studies done in Northern Nigeria[7,8,18] and Southern Nigeria,[14,20,22-24] other sub-Saharan African countries,[16,29] as well as some Asian countries.[27,30-32] However, BI was reported to be low (around 55%) of all stroke subtypes in few studies,[9,21,25] and reported as low as 40% in a study in Tanzania, sub-Saharan Africa.[33] A high value of about 80% of BI was reported by few authors in Nigeria[5,28] and Qatar,[32] which is similar to findings reported in many developed countries[4,5] but these findings differed with our finding.

In this study, ICH accounted for 33% of the cases. Many authors also reported similar findings on ICH in Nigeria,[7,8,18,20,22-25,34] other sub-Saharan African countries[16,29] and some Asian countries.[27,31] While, some researchers reported findings (range 44-46%) that were higher than our finding in Nigeria.[9,21] In some studies in Nigeria[5] and Asia[30,32] reported ICH accounted for about 20% of stroke cases, which is similar to what is obtained in developed countries.[4] However, Matuja and co-workers reported that the majority (54%) of stroke cases were ICH in a study in Tanzania.[33]

Subarachnoid haemorrhage was reported in 3% of the stroke patients in our study which agreed with previous studies in Nigeria[7,34] and other developing countries[30,31] but disagreed with some investigators who reported low values.[18,32] It is a subtype of stroke, but some authors did not consider SAH in their respective studies.[8,9,16,21,22,24,27-29] Onwuekwe *et al*[25] recorded as high as 16% of SAH cases in their studies in South-eastern Nigeria. Also, a study in North-central Nigeria reported 17% of SAH but it was in young adult patients.[19] These observations disagreed with our finding. Males predominate in all stroke subtypes in the present study, and this agreed with many authors,[5,16,21,24,28,30] while Taiwo *et al*[34] reported females dominance in BI in their study but Bello et al[20] reported no gender difference.

The left cerebral hemisphere was the most common site involved in this study; this is similar to the previous studies in Southern Nigeria.[5,21] This might be because the left hemisphere is the dominant side in most individuals. However, Taiwo *et al*[34] in North-central, Nigeria reported that stroke commonly involved the right hemisphere.

The index study showed that 13% of the patients had stroke mimics and they were mostly females with cerebral atrophy being the most common stroke mimic, followed by IC tumours. This was in concordance with previous authors who reported a frequency of 9-23% in Nigeria[20,21,23,25] and Pakistan.[27] However, Eze *et al*[24] recorded a low frequency of 6%, while Lutsi *et al*[28] and Ogun *et al*[26] reported higher values of 26% and 27% respectively in their studies, which differed from our finding. These showed the important role of CT scan in confirming the diagnosis of stroke and ruling out stroke mimics (differentials). Previous investigators also reported that the most common stroke mimic was cerebral atrophy in their respective studies,[21,26,28] while some authors[24,25] reported that the intracranial tumours were the commonest stroke mimic in their studies.

The limitations of the study were: it was a retrospective study, like most retrospective studies; clinical information was scanty which might affect the exclusion criteria like the history of recurrent stroke and stroke dating more than 15 days. Due to technical factors, the scanner was faulty within few weeks of the study period. Some suspected stroke patients could not do CT scan because of financial constraint during the study period. Some patients from surrounding villages could not travel to do CT scan at Maiduguri because of 'Boko haram' insurgency (insecurity) during the study period. Ignorance of some patients especially those living in rural areas might affect the patients turn out. All these factors might have affected the results of this study.

CONCLUSION

Stroke is a major cause of high morbidity and mortality worldwide and its trend increases in developing countries including Nigeria. In our study, 64% of the clinically diagnosed patients were confirmed with CT and the remaining was clinically misdiagnosed stroke. Brain infarction was the most common subtype and its proportion

was similar to what is obtained in most studies in developing countries. Stroke mimics are strong differentials of stroke and should be ruled out by CT scan. Computed tomography plays a vital role in the management of patients with stroke. Therefore, it is recommended in the evaluation of all stroke patients. Health caregivers, Government and non-governmental organisations should improve the public awareness of the role of CT scan in stroke management and should also make CT scan not only more available but readily affordable and accessible. Normal (negative) CT findings in clinically suspected stroke patients need further evaluation with MRI.

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