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RESEARCH ARTICLE

ECHOCARDIOGRAPHIC ABNORMALITIES IN YOUNG VERSUS OLDER ADULT STROKE CASES

[1*]Dr. Atoe- Imagbe Osagioduwa Mike, [2]Dr. Osarenkhoe Osaretin John, [1]Dr. Umuerri Ejiroghene [1]Dr. Aigbe Fredrick, [1]Dr. Aiwuyo Osarumme Henry and [3]Dr. Obasohan Austine

[1]Delta State University Teaching Hospital, Oghara, Nigeria; [2]Igbinedion University teaching hospital, Edo state, Nigeria; [3]University of Benin Teaching Hospital, Benin-City, Nigeria

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**Corresponding Author:*
Atoe- Imagbe Osagioduwa Mike

ABSTRACT

Background*:* There is an increasing prevalence of stroke in the young adults as well as older adults in general. Cardiovascular risks are a significant predisposition to occurrence of stroke in both age groups. Various cardiac abnormalities are present in stroke patients either as risk factors or as complications. A relationship exists between these cardiac abnormalities and the prevalence, morbidity and mortality from stroke. The changing pattern of the cardiovascular risk factors among these groups of patients may contribute to a changing pattern of cardiac and echocardiographic abnormalities in stroke patients. ***Objective****:* The aim of the study was to investigate the profile as well as prevalence of various echocardiographic abnormalities in young versus older adult stroke patients of the different subtypes of stroke. ***Method:*** Descriptive cross sectional and comparative study was done. 180 subjects comprising of 90 young(less than 45years) and 90 older (45years and above) adult stroke patients were recruited for this study. Echocardiography was done for the patients. Echocardiographic abnormalities were compared among the young versus the older groups using chi-square and t-test tests when necessary. ***Results****:* Mean age in the young and older stroke patients were 40.23 ± 2.75 and 65.77 ± 12.34 years respectively. Male to Female ratio was 1.6: 1 among the older group and 1.4: 1 among the young group. Ischaemic stroke was the commonest subtype of stroke in both groups of patients (54.4% in the young and 68.9% in the older group of patients). Intracerebralhaemorrhage and subarachnoid haemorrhage were present in 37.8% and 7.8% respectively in the young while 26.7% and 4.4% of the older group had intracerebral and subarachnoid haemorrhage respectively. Echocardiographic left ventricular hypertrophy was also the commonest structural abnormality on transthoracic echocardiography in both groups of patients (52.3% in the young versus 47.1%in the older group), and the difference in prevalence was not significant. Left ventricular systolic dysfunction was significantly more in the older patients than the young (21.1% versus 6.7% χ^2=7.850, p=0.005). Left ventricular diastolic dysfunction was slightly more in the older group (86.7%), compared with the young (75.6%). This difference was however not significant (χ^2=6.759, P=0.08). The commonest pattern of cardiac diagnosis was hypertensive heart disease in both groups of patients (68.9 versus 65.5%).Others were valvular heart disease (6.7% both groups), ischaemic heart disease (2.2% and 5.5% in the young and old respectively), pericardial diseases (2.2% and 5.5% in the young and old respectively) dilated cardiomyopathy (1.1%) and hypertrophic cardiomyopathy (1.1%) both in the older group and left atrial myxoma (1.1%) in the young group. ***Conclusion****:* Transthoracic echocardiographic structural and functional abnormalities were largely similar among both age groups with slight differences noted. Left ventricular systolic dysfunction was significantly more on echocardiography among the older group of patients. It is therefore important to screen adult patients with stroke irrespective of the age at presentation.

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INTRODUCTION

Stroke by the American Heart Association/American Stroke Association (AHA/ASA) is the sudden onset of global neurologic deficit of vascular aetiology, with objective evidence of central nervous system infarction or haemorrhage irrespective of the duration of clinical symptoms.

Stroke is a major cause of morbidity and mortality in Blacks. In the Western world it is the second leading cause of death and a major cause of disability, and it has been on the rise in Africa. Broadly, stroke can be categorized into ischaemic and haemorrhagic subtypes.[1-5] The rising incidence of stroke in young adults have been documented in several studies, however it is well established that stroke is more prevalent in the older population. While a specific definition of the "young stroke" is lacking, the vast majority of authors consider "young stroke" to pertain to individuals less than 45

years of age. The 45years age cut off has been used for several international and local studies to investigate the peculiarities of stroke in the young people. [5-12] Earlier studies reported incidence rates of stroke in the young to be between 7.22% and 26.95% of all stroke cases studied. There is an increasing prevalence globally and this is reported to be higher in developing countries. Cardiogenic embolism accounts for 15% to 30% of ischemic stroke in the general population. Mitral valve disease, which accounts for a significant proportion of cardio embolic stroke in young patients, is more common in developing countries due to a high prevalence of rheumatic heart disease. [7,13-16] Despite the reducing prevalence of rheumatic heart disease (previously described as the commonest of cardiac abnormalities in young stroke patients in children and young adult there is still an increasing incidence of stroke in young adults suggesting a possibility of other aetiologies like hypertension, as seen in older adults.Other conditions leading to cardio embolic stroke include atrial fibrillation(AF), non-rheumatic valvular heart diseases, congenital heart disease (e.g. patent foramen ovale), acute myocardial infarction, left atrial myxoma, left ventricular aneurysm/dysfunction, left atrial/ventricular thrombus, hypertrophic obstructive cardiomyopathy, and prosthetic valve. These have been reported from various studies.[8,16-21]\l " A combination of clinical assessment, echocardiographyand ancillary investigations improves diagnostic yields in the assessment of cardiac and stroke abnormalities. Stroke is a major cause of morbidity and mortality worldwide. Globally, 15million people are affected by stroke and one-third of those affected die annually while another one-third are left permanently disabled. Without intervention, the number of global deaths was projected to rise to 6·5 million by 2015 and would increase to 7·8 million in 2030. This rising burden of stroke weighs heavily on low and middle-income countries, especially the Black population[23-26] The prevalence of stroke in Nigeria was 1·14 per 1000 while the 30-day case fatality rate is as high as 40% in 2011.Sanya *et al* in Ilorin, Nigeria in the year 2015 reported the prevalence of stroke to be 1.31 per 1000 persons, depicting a rising incidence. The young constitute a majority of the work force of any country, and inevitably determine the productivity of such a nation. Stroke is the commonest cause of acquired disability worldwide. In 1990, Disability Adjusted Life Years was 38million worldwide, and this is projected to rise to 61million DALYs in 2020.[9,27-29] Cardiac abnormalities are a significant finding in stroke patients especially in the young. These abnormalities have been described as both risk factors for stroke and complications resulting from the cerebral events. The coexistence of cardiac abnormalities ranging from arrhythmias, structural changes, congenital defects, intra-cardiac clots and tumors, with stroke makes morbidity and mortality higher in stroke patients. The existence of cerebrovascular disease with various cardiac abnormalities has been described in several studies in which echocardiography was used to screen for cardiac abnormalities in patients with stroke. However there still exist controversies regarding routine evaluation of all stroke patients irrespective of the age or a clinical suspicion of cardiac abnormalities, using these tools[15,21,23,30-33] Only a few studies have been done to compare the profile and prevalence of echocardiographic abnormalities in the young and old stroke patients. A few of the available studies compared only a few number of young patients with a larger proportion of older stroke patients and as well as recruited only patients with ischaemic stroke in these comparatives. Furthermore, results from this study will be useful in the formulation of protocol in various cardiology units and stroke centre to guide evaluation and monitoring of patients with cardiac abnormalities and to institute proper care in our health care facilities. [19,34,35]

RESULTS

IVSDs: Interventricular septal diameter in systole; IVSDd: Interventricular septal diameter in diastole; ARd: Aortic root dimension; LV: left ventricular; LVIDs: LV internal diameter in systole; LVIDd: LV internal diameter in diastole; LVPWDs: LV post wall diameter in systole; LVPWDd: LV post wall diameter in diastole; TAPSE: tricuspid annular plane systolic excursion LAD:

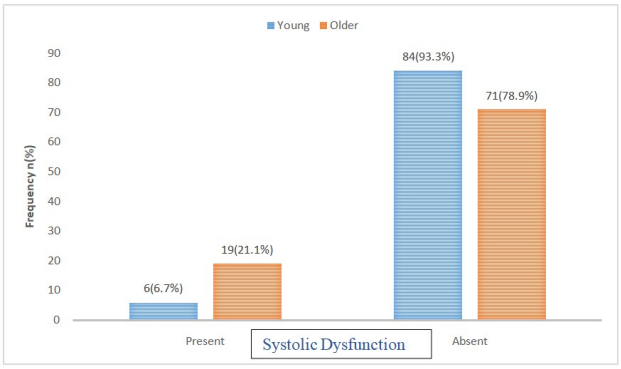
Table 1. Echocardiographic Indices of Patients Using 2-D Imaging

	<45years (n=90)	≥45years (n=90)		
	Mean ±SD	Mean ±SD	t	P-value
IVSDs (mm)	16.11 ±4.41	16.35 ± 3.36	0.407	0.685
IVSDd (mm)	11.91± 2.83	12.07 ±3.18	0.349	0.727
ARd (mm)	29.99 ± 4.70	30.03± 6.23	0.054	0.957
LVIDs (mm)	29.09± 6.65	30.55 ±11.05	1.074	0.284
LVIDd (mm)	45.86± 7.73	49.16 ± 9.01	2.640	0.009*
LVPWDs (mm)	15.59 ± 3.02	15.93 ± 3.57	0.676	0.500
LVPWDd (mm)	10.44 ± 4.03	9.68 ± 2.94	1.444	0.150
LV mass (g)	187.96 ±94.73	208.59 ±101.32	1.411	0.160
LV mass index(g/m^2)	108.38 ±50.85	113.55±52.97	0.668	0.505
TAPSE (mm)	23.49 ± 4.72	23.05 ±5.84	0.557	0.578
LAD(mm)	33.98 ± 5.62	36.16 ± 6.51	2.407	0.017*
Fractional shortening (%)	38.33± 8.14	40.00±11.46	1.132	0.259
LV ejection fraction (%)	67.07±9.80	66.21±14.83	0.462	0.644

*p value<0.05

Left atrial linear diameter. Table I show that left ventricular internal diameter in diastole (LVIDd) and Left atrial linear diameter (LAD) are significantly more in older stroke patients.

Echocardiographic findings using doppler imaging in above patients: The mean Iso-volumetric relaxation time (IVRT) was higher in the younger group (0.13± 0.04s) compared with the older group (0.12±0.04s), but the difference was not significant (p=0.15).The mean Systolic velocity (Svel) was 8.39±2.04 in young and slightly higher than 8.28±2.50 in the older group, the difference was however not statistically significant (p=0.736). The mean E prime Velocity (7.25±2.49 versus 6.59±2.31, p=0.067), A prime velocity (9.14±2.66 versus 8.69±2.64, p = 0.250), mean septal E/e' ratio (10.29±6.63 versus10.39±4.23, p=0.899), E/A ratio (0.88±0.35 versus 0.84±0.35, p=0.471) were not statistically different in the young group when compared with the older group respectively.

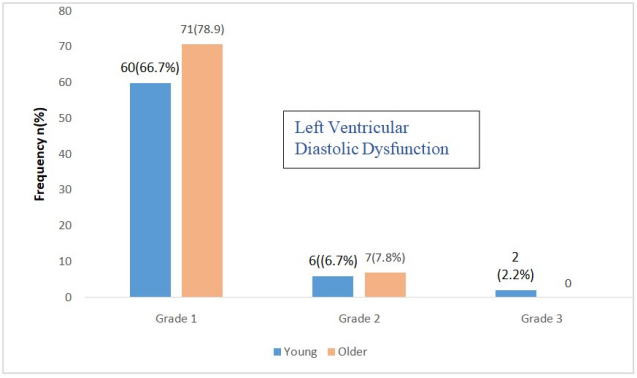


Chi square 7.850; p-value = 0.005

Figure 1. Prevalence of left ventricular systolic dysfunction among study participants

PREVALENCE OF LEFT VENTRICULAR SYSTOLIC DYSFUNCTION AMONG STUDY PARTICIPANTS (Figure 1): Left ventricular systolic dysfunction was more in older patients (21.1%) than the Young (6.7%) and there was a statistically significant difference between the prevalence of Left ventricular systolic dysfunction in the older participants when compared to young (p=0.005).

LEFT VENTRICULAR DIASTOLIC FUNCTION AMONG PATIENTS (Figure2): Diastolic dysfunction was commoner among older participants compared to young (86.7% versus 75.6%).



(Chi-square: 6.759; p=0.080)

Figure 2. Left ventricular diastolic dysfunction function among participants

In comparison, 79% versus 66.7%, had grade1(mild),7.8% versus 6.7% had grade 2(moderate), while 0.0% versus 2.2% was found to have grade 3(severe) in the older and young group respectively. There was no significant difference in the occurrence of diastolic dysfunction among the two groups of patients with stroke (Chi-square: 6.759; p=0.080). LAE: Left Atrial Enlargement; LVH: Left ventricular hypertrophy; VHDX: Valvular heart disease; DCM; Dilated cardiomyopathy: LAM; left atrial myxoma :LAT; Left atrial thrombus, LVT: Left ventricular thrombus.

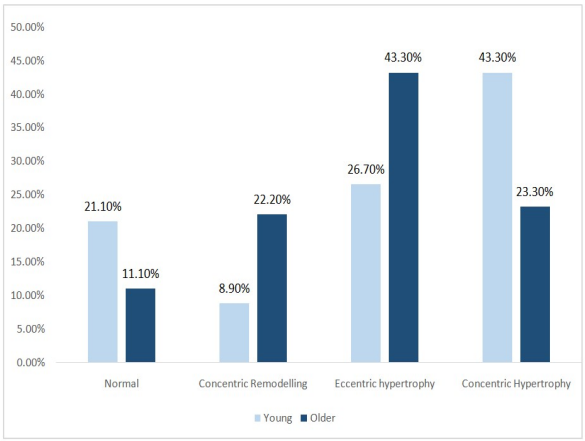


Figure 3. Left ventricular geometric among Study participants

ASSOCIATION OF ECHOCARDIGRAPHIC FINDINGS WITH AGE GROUPS OF STROKE PATIENTS (Table 3): The commonest finding on echocardiography among both groups is left ventricular hypertrophy either alone or in combination with other echocardiographic findings. There were less structural abnormalities in the young, compared with the older patients even though there were no statistically significant differences (17.1% versus 8.1%, p=0.068).

Overall, Left ventricular hypertrophy was found in 52.3% of the young which was higher than the47.1% in the older patients with stroke. However there was no significant statistical difference (p=1.000). Valvular heart disease was found in 6.7% patients in both groups while all 6(6.7%) among the young was predominantly rheumatic mitral valve disease, 3 among the older group were aortic valve disease, 2 of them had rheumatic mitral valve disease and only one of them had aortic valve prosthesis.Left atrial enlargement was more in the older group (24.3%) compared with young (17.1%) it was in different combinations with LVH, Left atrial thrombus and left ventricular thrombus the difference in the prevalence in both groups was not statistically significant(p=0.065).The pericardial disease was also slightly commoner in the older group compared with the young (5.5% versus 2.2%) but there were no statistically significant differences (p=0.441).

ASSOCIATION OF STRUCTURAL ABNORMALITIES WITH PATHOLOGIC

TYPES OF STROKE (Table 4)

Young Patients: Left ventricular hypertrophy (67.3% versus 60.8%,p=0.529), valvular heart disease (10.2% versus 2.5%,p=0.214), left atrial and ventricular thromboses (10.2% versus 2.5%, p=0.214), Left atrial enlargement(26.5% versus14.6%,p=0.168)were more frequent in ischaemic stroke compared to haemorrhagic stroke among the young group of patients, but the differences were not statistically significant.Pericardial diseases was more frequent (4.9%) among patients with haemorrhagic stroke and none in those with ischaemic stroke but there was no statistical difference in prevalence among the types of stroke(p=0.205)

Older Patients: Left ventricular hypertrophy (71% versus 50%, p=0.054), valvular heart disease (8.1% versus 3.6%, p=0.661), and dilated cardiomyopathy (1.6% versus 0.0%, p=1.000), left atrial enlargement (37.1% versus 25%, p=0.260) was more in patients with ischaemic stroke compared to haemorrhagic stroke. There was no statistically significant differences in the structural abnormalities among both types of stroke. Left atrial and ventricular thrombus were present in comparably similar proportions of patients with ischaemic(14.5%) and haemorrhagic stroke types (14.3%) the difference was not statistically significant (p=1.000).The pericardial disease was more frequent among haemorrhagic stroke (10.8%) in the older group, compared to ischaemic stroke (3.2%) but the difference was not statistically significant (0.172).

LEFT VENTRICULAR GEOMETRIC PATTERN AMONG STUDY PARTICIPANTS (Figure 3): Among the subjects, 21.1% of young patients with stroke had normal left ventricular geometric pattern, while only 11.1% of the older group had normal geometry of their left ventricles on echocardiography. Eccentric left ventricular hypertrophy (26.7% versus 43.3%), concentric left ventricular hypertrophy (43.3% versus 23.3%) and concentric remodeling (8.9% versus 22.2%), were present in the young versus older patients respectively. Concentric hypertrophy was the commonest pattern in the young group(43.3%), while eccentric hypertrophy was most prevalent(43.3%) in older stroke patients.

ASSOCIATION OF LEFT VENTRICULAR GEOMETRIC PATTERN WITH AGE IN DIFFERENTTYPES OF STROKE (Table 5): There was a statistically significant difference in the prevalence of different left ventricular geometric patterns as follows; Normal geometry (24.4% versus 17.9%), concentric remodeling (7.3% versus 32.1%), concentric hypertrophy (43.9% versus 10.7%) and eccentric hypertrophy(23.4% versus 39.3%) in the young patients with haemorrhagic stroke when compared to the older patients (p=0.004). On the contrary, the pattern of left ventricular geometry as follows; Normal geometry (18.4% versus 8.1%), concentric remodeling (10.2% versus 17.7%), concentric hypertrophy (42.8% versus 29.0%) and eccentric hypertrophy (28.6% versus 45.2%) was not significantly different in prevalence between young and older patients with ischaemic stroke (p=0.07).

PATTERNS OF LEFT VENTRICULAR GEOMETRY AMONG THE DIFFERENT TYPES OF STROKE IN YOUNG AND OLD (Table 6): Left ventricular geometric patterns in young patients {normal geometry (18.4% versus 24.4%, concentric remodeling (10.2% versus 7.3%), concentric hypertrophy (42.8% versus 44.0%) and eccentric hypertrophy (28.6% versus 24.3%)} was not significantly different in prevalence among ischaemic and haemorrhagic stroke types respectively (p=0.862). Similarly, there was also no significant difference in the prevalence of different left ventricular geometric patterns among the older patients {normal geometry (8.1% versus 17.9%), concentric remodeling(17.7% versus 32.1%), concentric hypertrophy (29% versus 10.7%) and eccentric hypertrophy (45.2% versus 39.3%)}with ischaemic when compared to haemorrhagic stroke respectively (p=0.094).

Table 5. Left ventricular geometric pattern among stroke types in the young versus older patients

Variable		Age-group Frequency (%)		Chi-square	p-value
	LV geometry	Young n=41	Older n=28		
Haemorrhagic	Normal	10(24.4)	5(17.9)		
	Concentric remodeling	3(7.3)	9(32.1)		
	Concentric hypertrophy	18(43.9)	3(10.7)		
	Eccentric hypertrophy	10(23.4)	11(39.3)	13.457	0.004
	LV geometry	n=49	n=62		
Ischaemic	Normal	9(18.4)	5(8.1)		
	Concentric remodeling	5(10.2)	11(17.7)		
	Concentric hypertrophy	21(42.8)	18(29.0)		
	Eccentric hypertrophy	14(28.6)	28(45.2)	6.862	0.07

[LR] Likelihood ratio

Table 6. Patterns of left Ventricular Geometry among the different types of stroke in young and old

Variable		Types of Stroke Frequency (%)		Chi-square	p-value
	Young	Ischaemic n=49	Haemorrhagic n=41		
LV geometry	Normal	9 (18.4)	10(24.4)		
	Concentric remodeling	5(10.2)	3(7.3)		
	Concentric hypertrophy	21(42.8)	18(44.0)		
	Eccentric hypertrophy	14(28.6)	10(24.3)	0.747[LR]	0.862
	Older	n=62	n=28		
LV geometry	Normal	5 (8.1)	5(17.9)		
	Concentric remodeling	11(17.7)	9(32.1)		
	Concentric hypertrophy	18(29.0)	3(10.7)		
	Eccentric hypertrophy	28(45.2)	11(39.3)	6.392	0.094

[LR] Likelihood ratio

DISCUSSION

Stroke is a major contributor to cardiovascular disease burden both in Africa and in the world at large. The mean age of patients in the young group (selected from among 18 and 44 years of age) in this study was about40years. This mean was similar to the 38years reported from a previous work done by Razzaq *et al* in South East Asiaamong young stroke patients (between 15 and 44years of age).
These means were however higher than the 31years mean that was reported from a similar study (that compared cardiovascular risk factors in young stroke patients aged 15 and 44years compared with older stroke patients) by Karaye *et al* in Kano Nigeria.[10,34] The dissimilarity in mean age may be accounted for by the variation in the sample sizes of the study population in this current study and Karaye *et al*'s study; Karaye *et al* included only 15 young patients and 65 older adult stroke patients, while this study recruited 90 young and 90 older adult stroke patients. On the other hand, the mean age of those in the older group was about 65years (selected from patients 45years and above). This mean age was similar to that recorded among adult stroke patients (40years and above) in Port Harcourt, Nigeria by Ezennaka *et al*. As expected, the age difference between the young and older groups of participants in this study was statistically significant.[22] Male to female ratio among the participants shows a male preponderance in both age groups of stroke patients. The male sex is known to be a risk factor for stroke, especially in younger patients, except in postmenopausal women who have comparable or a higher risk. This finding of male preponderance is similar to that reported by Kolo *et al* in Ilorin, south-west Nigeria and Fromm *et al* in Bergen, Norway[23,35,39]

ECHOCARDIOGRAPHIC FINDINGS: Transthoracic echocardiography is now part of the routine diagnostic workup of cardiac sources of embolism in stroke patients in many centre across the world. Various abnormalities were found on echocardiography from this study. Abnormalities include left atrial dilatation and right atrial enlargement left ventricular dilatation, left ventricular systolic dysfunction and diastolic dysfunction, abnormal Left ventricular geometry and other structural abnormalities. There was a significantly higher prevalence of abnormalities in the older group compared with the young stroke patients.[47,48] This finding is similar to reports from the comparative study of young and predominantly older stroke patients by Karaye *et al* in Kano and Fromm *et al* in Norway but contrasts the report from Subha *et al* in India in which predominantly younger patients who had more prevalence of background heart disease and significant alcohol use were recruited. This current study recruited an equal number of young and older patients and it's expected to help reduce selection bias.[37,38] Abnormalities in the echocardiographic indices of stroke patients included a significant increase in mean LVMI and RWT in both young and old. In both study groups, over two-thirds of the patients had a significant increase in mean LVMI. Echocardiographic left ventricular hypertrophy was the commonest structural abnormality in both age groups. Abnormal left ventricular geometry was present in over two-thirds of both age groups, with a trend towards more concentric remodeling in the younger group and eccentric remodeling in the older group. This finding is similar to reports from previous works and all forms of left ventricular hypertrophy were more associated with ischaemic stroke in this current study similar to what was previously reported. [43,44,49,50]
The mean left atrial diameter was significantly more in the older group compared to the young, and the prevalence of echocardiographic left atrial dilatation was slightly more in the older group (23% versus 17% of older and young respectively) This may be a reflection of the increase in atrial size that occurs with worsening diastolic function.Tsujikawa *et al* in China, Japanreported a trend towards increase in left atrial size with increasing age in patients with cerebral infarction. This is probably a contribution from the effects of diastolic dysfunction which is more prevalent among the older group

of patients, that may predispose to increasing left atrial dimension and resultant increased risk of arrhythmogenicity, and formation of thrombus predisposing to stroke.[40,41,49,51] The mean Left ventricular internal diameter in diastole was also higher in this study among the older patient when compared with the young group. This may be due to the higher prevalence of eccentric left ventricular hypertrophy among the older age groups in this study. Andren *et al* in Sweden had previously reported that eccentric hypertrophy is commoner in the older age groupand left ventricular dilatation has been associated also with increased risk of cardio embolic stroke as reported in previous studies[42,43,50] Valvular heart disease was comparably similar in both young and older groups of stroke patients. Though low in both groups, it is comparable to reports from Ezennaka *et al* in Port-Harcourt and lower than the prevalence reported from Yau *et al* in Kano, Nigeriaand Kolo *et al*.\l "Presence of thrombus was more prevalent in older patients when compared with the young (14% versus 7.1%), it was not statistically different among both groups. It, however, constitutes a high prevalence similar to report from a study by Kolo *et al* that recorded a total of 6.4% as a source of thrombus, and Ezennaka *et al*(6%),suggesting the significance of thrombus formation as a risk factor for stroke. [24,25,36] However, these previous studies did not compare prevalence in the young and older patients. This current study found a higher prevalence in the older group, probably because the same group had a higher prevalence of systolic dysfunction, left atrial enlargement and left ventricular diastolic dysfunction, that is pathophysiologically linked to thrombus formation as earlier explained. Once stroke due to cardiac embolism has occurred, the likelihood of recurrence is high for most sources. Consequently, secondary prevention is very important to prevent a repeat stroke. Left ventricular systolic dysfunction has been associated with an increased risk of ischaemic stroke irrespective of the age of the patient and degree of systolic dysfunction. Left ventricular systolic dysfunction increases blood stasis both in the left ventricular cavity and left atrium, creating a nidus for thrombus formation, with an increased risk of ischaemic stroke. Left ventricular systolic dysfunction was significantly higher in the older age group compared with the young. This finding among the older patients is slightly higher than the prevalence from the study by Ezekowitz *et al* in the USA. There was, however, no comparison among age groups in that study.[45,46,52] The prevalence of left ventricular diastolic dysfunction obtained in this study was high in both groups of patients and was not significantly different among both age groups. It was however higher than that reported by Nakibuuka *et al* in Uganda among ischaemic stroke patients. This may be due to a lower prevalence of hypertension in the patients studied in Uganda. Left ventricular diastolic dysfunction supposedly has a direct impact on recurrent events through impaired left atrial contractility and intracardiac stasis, both of which increase the possibility of thromboembolism. More so diastolic dysfunction has been previously associated with poor outcome and increased mortality in ischaemic stroke patients.[16,53] Overall, the echocardiographic structural abnormality was more prevalent in the older group compared to the young, but there was no significant difference in the pattern and prevalence of the findings in both the young and the older groups of patients as the cardiovascular risk factors were found to be similar in both groups

CONCLUSION

Echocardiographic structural abnormalities including left ventricular hypertrophy were also not significantly different among both age groups, though slight variations in prevalence were noted from the study.However, left atrial dilatation, left ventricular systolic dysfunction and arrhythmias were significantly more in the older patients compared with the young patients.

RECOMMENDATION: Echocardiography should be included as part of the initial diagnostic work up in both young and older groups of patients.

LIMITATIONS OF THE STUDY: Baseline echocardiograpy was not assessed prior to occurrence of stroke as some of the changes identified in this study may be premorbid,.

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