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The Role of Echocardiography in the Management of Stroke

Le rôle de l'échocardiographie dans la gestion des maladies

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ABSTRACT

BACKGROUND: **Echocardiography is increasingly being used as a screening test to identify sources of cardiogenic embolism in patients with ischemic stroke or transient ischaemic attack (TIA). However, no consensus exists presently on the utilization of this imaging facility in individuals with stroke.**

OBJECTIVE: **To evaluate the yield of transthoracic echocardiography in patients with ischaemic stroke with a view to providing guidance in its use in clinical management of stroke.**

METHODS: **One hundred and twenty-six consecutive stroke patients with 90 controls were recruited prospectively. Patients were examined echocardiographically for evidence of intra-mural thrombus, congenital defects, valvular heart disease, wall motion abnormalities and intra-cardiac masses using two-dimensional, m-Mode and Doppler facilities.**

RESULTS: **Potential cardiac source of emboli (CSE) was identified in 23.0% of the stroke patients. Those who had CSE identified aged 53.0(20.8) years were younger (p=0.0001) than those who did not have CSE, 57.2 (13.5) years. Five (4.0%) patients had rheumatic valvular heart disease with demonstrable clots in the left atrium. On the other hand, four(3.2%) patients had RHD without thrombi seen. Two patients had biventricular thrombi. One of these patients had giant clots within the ventricles and multiple freely mobile thrombi in right ventricle without obvious cardiac structural defect.**

CONCLUSION: **Young stroke or transient ischaemic attacks patients who have clinical signs suggesting the heart as the potential CSE should have low threshold for echocardiography. However, there is a need for rationalisation of request for echocardiography where such clinical signs are absent. WAJM 2010; 29(4): 239–243.**

Keywords: **Stroke, cardiac source of thrombus, transthoracic echocardiography, Nigeria.**

RÉSUMÉ

CONTEXTE: L'échocardiographie est de plus en plus utilisé comme un test de dépistage pour identifier les sources d'embolie cardiogénique chez les patients ayant subi un AVC ischémique ou d'accident ischémique transitoire (AIT). Toutefois, aucun consensus n'existe actuellement sur l'utilisation de cette installation d'imagerie chez les individus ayant subi un AVC.

OBJECTIF: Pour évaluer le rendement de l'échocardiographie transthoracique chez les patients ayant un AVC ischémique en vue de fournir des orientations de son utilisation dans la gestion clinique de l'AVC.

Méthodes: Cent vingt-six années consécutives de patients victimes d'AVC de 90 témoins ont été recrutés de façon prospective. Les patients ont été examinés échocardiographie des preuves de thrombus intra-muros, des anomalies congénitales, les cardiopathies valvulaires, des anomalies de cinétique et des masses intra-cardiaque à l'aide de deux dimensions, en mode M et des installations de Doppler.

RÉSULTATS: source potentielle d'embolie cardiaque (CST) a été identifié dans 23,0% des patients AVC. Ceux qui avaient identifié le CST âgés de 53,0 (20,8) ans étaient plus jeunes (p = 0,0001) que ceux qui n'ont pas eu le CST, 57,2 (13,5) ans. Cinq (4,0%) patients avaient une cardiopathie valvulaire rhumatismale avec des caillots démontrable dans l'oreillette gauche. D'autre part, quatre (3,2%) patients avaient conduite à droite, sans thrombus visible. Deux patients ont eu thrombus biventriculaire. Un de ces patients avait des caillots de géant dans les ventricules et multiples thrombi mobiles librement dans le ventricule droit sans évident défaut structurel cardiaque.

CONCLUSION: accident vasculaire cérébral ischémique transitoire ou jeunes patients attaques qui ont des signes cliniques suggérant le cœur comme l'ESC potentiels devraient avoir à bas seuil pour l'échocardiographie. Cependant, il ya un besoin de rationalisation de la demande de l'échocardiographie où ces signes cliniques sont absents. WAJM 2010; 29 (4): 239–243.

Mots-clés: accident vasculaire cérébral, source de thrombus cardiaque, une échocardiographie transtthoracic, Nigeria.

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Abbreviations: AF, Atrial Fibrillation; **CHD,** Congenital Heart Disease; **CSE,** Cardiac Source of Embolus; **DM,** Diabetes Mellitus; **ECG,** Electrocardiographic; **HBP,** High Blood Pressure; **HHF,** Hypertensive Heart Failure, **HIV,** Human Immunodeficiency Virus, **LAE,** Left Atrial enlargement, **LBBB**, Left Bundle Branch Block; **LVH,** Left Ventricular Hypertrophy, **NSST,** Non-specific; **PAC,** Premature Atrial Contraction; PPCM-peri-partal Cardiomyopathy, **PVC,** Premature Ventricular Contraction, **RBBB,** Right Bundle Branch Block; **RHD,** Rheumatic Heart Disease, **SC,** Segment Changes, **ST,** Sinus Tachycardia; **TIA,** Transient Ischaemic Aattacks.

INTRODUCTION

Stroke is a rapidly developed focal or global neurological deficit lasting more than 24 hours or leading to death with no apparent cause other than vascular origin.[1] It is a major cause of morbidity and mortality worldwide.[2] There are two main types of stroke; namely ischaemic and haemorrhagic. The former could be thrombotic or embolic while the latter could be intracerebral haemorrhage or subarachnoid haemorrhage. Cardiogenic embolism accounts for 15% to 30% of ischaemic stroke.[3] Potential cardiac sources of embolus (CSE) include atrial fibrillation, valvular heart disease, congenital heart disease, acute myocardial infarction and atrial myxoma. Others are left ventricular aneurysm, left atrial thrombus, patent foramen ovale, mitral valve prolapse and left ventricular dysfunction. In patients who suffered stroke and survived, it is very important to identify these possible sources of thrombus in order to reduce the risk of re-occurrence.[4] Echocardiographic procedures, both transthoracic (TTE) and transesophageal (TEE) are commonly used to screen for potential cardiac sources of embolus in patients with stroke. However, the routine use of echocardiography in patients with stroke has generated a lot of debate.[5–6] The concern bothers mainly on the cost-effectiveness of the procedures and whether or not, it leads to alteration of management of the patients, particularly anticoagulant treatment.[7] In addition, there is gradual overstretching of outpatient echocardiographic services in many centers. At present, there are no guidelines for the conduction of echocardiographic examination in patients with stroke in our centre and elsewhere in Nigeria. This study, therefore, had the aim of determining the diagnostic yield of TTE in identifying cardiac source of embolus in our patients with stroke and to make recommendations on its routine use in such individuals.

SUBJECTS, MATERIALS, AND METHODS

Consecutive patients with diagnosis of stroke and who were referred for echocardiography to determine CSE were recruited prospectively over a three-year period between January 2006 and December 2008. Patients were referred for the test at the discretion of the managing physicians. Written informed consent was obtained from the patients and clearance was sought from the Ethics and Research Committee of the hospital. Patients' biodata, indications for echocardiographic evaluation and risk factors for stroke in the patients were documented. A standard 12-lead electrocardiogram (ECG) was done for each patient.

All patients were examined echocardiographically for CSE using Esaote Megas CVX machine (2003 model) which has facilities for two dimensional (2D), m-Mode, and color flow, pulsed and continuous wave Doppler. Abnormal echocardiogram with or potential CSE was defined as the presence of intramural thrombus, congenital heart disease, rheumatic heart disease, spontaneous echo contrast in heart chambers, wall motion abnormality and intra-cardiac masses. Patients who did not have CSE were age- and sex-matched with healthy normotensive (Blood pressure below 140/90mmHg) controls. Healthy normotensive subjects were recruited in order to determine the reference value of echocardiographic indices in our environment and for comparison with parameters of the patients. Willing volunteers were recruited from amongst members of hospital staff, students and patients from outpatient departments with non cardiac signs and symptoms. Cardiac dimensions in patients and controls were assessed using long Parasternal 2D-guided m-Mode echocardiogram according to standardized methods as recommended by the American Society of Echocardiography (ASE) and as reported previously elsewhere.[8–10] Left ventricular hypertrophy (LVH) alone without other structural heart lesions was not considered to be CSE.

Statistical Analysis: Statistical analysis was performed using the SPSS Version 15. Numerical values are presented as mean ± standard deviation. Student's t-test was used to compare means of continuous variables while chi-square test was used to compare means of proportions. A statistically significant association was taken as $P<0.05$

RESULTS

One hundred and twenty-six stroke patients consisting of 76 (60.3%) males and 50 (39.7%) females were recruited into the study. Their ages ranged from 20 to 93 years with a mean of 56.3 ±15.4 years. Table 1 shows clinical risks for stroke in the patients and the ECG diagnoses of the patients. Systemic hypertension either alone (65.1%) or in association with diabetes (12.7%) was the commonest risk

Table 1: Clinical Risk Factors for Stroke and Electrocardiographic Findings

	Number (%)
Risk for CSE	
None	4(3.2)
HBP	82(65.1)
HBP + DM	15(12.7)
RHD	8(6.3)
HHF	4(3.2)
AF	4(3.2)
Cardiac Masses	2(1.6)
HIV	2(1.6)
PPCM	2(1.6)
CHD	2(0.8)
Artificial Valve	1(0.8)
ECG Diagnosis	
Normal	6(4.8)
LVH	43(34.1)
LVH + LAE	21(16.7)
LVH + PVC	10(7.9)
LVH + PAC	4(3.2)
LBBB	9(7.1)
RBBB	5(4.0)
LAE	12(9.5)
AF	10(7.9)
NSST	4(3.2)
ST	2(1.6)
Total	**126(100.0)**

AF, atrial fibrillation; CHD, congenital heart disease, CSE, cardiac source of embolus, DM, diabetes mellitus, ECG, electrocardio-graphic, HBP, high blood pressure, HHF, hyper-tensive heart failure, HIV, human immuno-deficiency virus, LAE, left atrial enlargement, LBBB, left bundle branch block, LVH, left ventricular hypertrophy, NSST, non-specific PAC, premature atrial contraction, PPCM, peri-partal cardiomyopathy, PVC-premature ventricular contraction, RBBB, right bundle branch block, RHD, rheumatic heart disease, ST, segment changes, ST, sinus tachycardia.

Table 2: Frequency of Findings Echocardiographic in Stroke Patients

Echocardiographic Finding	Number (%)
Normal	1 (0.8)
LVH	96 (76.2)
Biventricular thrombus	2 (1.6)
Left ventricular thrombus	1 (0.8)
RHD with left atrial thrombus	5 (4.0)
RHD without thrombus	4 (3.2)
DCM with echo contrast	9 (7.1)
Congenital heart disease	3 (2.4)
Left atrial myxoma	2 (1.6)
Dilated left atrium	2 (1.6)
Artificial aortic valve	1 (0.8)
Total	**126(100.0)**

Key: LVH, left ventricular hypertrophy, DCM, dilated cardiomyopathy, RHD, rheumatic heart disease.

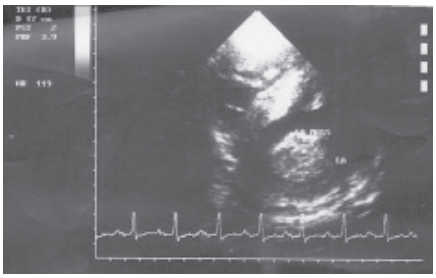

Fig. 1: 2-D Echocardiogram of a 40-year old Nigerian with rheumatic mitral valve disease and a giant clot int he left atrium.

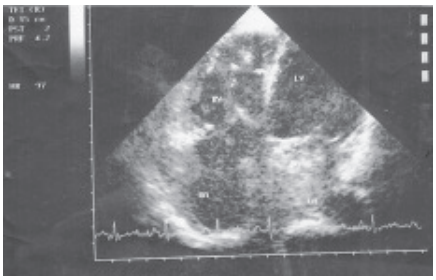

Fig. 2: A apical four-chamber view of a patient with a large highly echogenic mass in the left atrium compartible with atrial myxoma.

factor identified for stroke in the patients studied. This was followed by rheumatic valvular heart disease (6.3%), heart failure (3.2%) and atrial fibrillation (3.2%). Two patients each were suspected to have cardiac masses, HIV cardiomyopathy and peri-partal cardiomyopathy while, one patient each had congenital heart disease and artificial aortic valve. However, four patients did not have any risk identified. Left Ventricular Hypertrophy was the commonest ECG abnormality found in the patients occurring in 61.9% of the patients which correlated well with echocardiographic LVH (R=0.52, p=0.0001). However, atrial fibrillation was diagnosed in 7.9% and left bundle branch block was seen in 7.1% of cases.

Echocardiographic findings of the patients are displayed in Table 2. Left Ventricular Hypertrophy was the most prevalent (76.2%) echocardiographic diagnosis in the patients. Majority of patients without CSE had systemic hypertension as the risk factor for stroke and LVH was the commonest echocardiographic finding in them. The remaining patients (23.0%) had thrombi, spontaneous echo contrast or structural heart disease. Patients with CSE (meann age, 53.0 ± 20.8 years) were younger (p=0.0001) than those without CSE (57.2 ± 13.5 years). Two patients had biventricular thrombi. One of the patients with biventricular thrombi had giant clots with multiple small freely mobile thrombi in the right ventricle. He died of pulmonary thrombo-embolism. Five (4.0%) patients had rheumatic valvular heart disease with demonstrable clots in the left atrium. On the other hand, four patients (3.2%) had RHD without thrombi seen. One of these patients developed sudden onset of left sided limb weakness while watching a football match involving the Golden Eaglets of Nigeria. One of the patients with left atrial myxoma was a 20-year-old medical student who was being worked up for cardiac surgery. One of the studied subjects each had artificial aortic valve and normal study.

Table 3 compares the echocardiographic findings of patients without CSE with those of normotensive healthy controls. The mean ages of the two groups were similar but the right and left ventricular dimensions are significantly higher (p=0.001) in the patients than in the normotensive subjects. The mean LVMI, AOD, LAD and RWT are significantly higher (p = 0.001, 0.001, 0.001 and 0.001) in the patients than in the control subjects.

Figure 1 shows 2-D echocardiogram of a 40 year old Nigerian with rheumatic mitral valve disease and a giant clot in the left atrium while Figure 2 is an apical four chamber view from another patient with a large highly echogenic mass in the left atrium compatible with atrial myxoma.

DISCUSSION

The main finding of this study is that 23.0% of the patients studied had intracardiac clots, spontaneous echo contrast or structural heart lesions that are potential CSE. That notwithstanding, only 8 (6.3%) patients had visible intracardiac thrombi. Majority of stroke patients referred for echocardiographic evaluation in our centre had systemic hypertension as the sole risk factor and echocardiographic LVH (echo LVH) was the commonest finding in them which correlated positively with ECG LVH. These findings concur with results of previous echocardiographic studies in unselected stroke patients.[11, 12] Only one patient had normal echocardiography. Patients with potential CSE were younger (p=0.001) than those without CSE and most of them had clinical signs of cardiovascular disease. This means that younger stroke patients are more likely to have CSE than older individuals.[13, 14] It is of note from our study that about 24% of patients who had hypertension as the only risk factor were less than 45 years old. Indeed, systemic hypertension is becoming a major cause of stroke in the young among our populace and every effort should be made to identify individuals at risk and treat them early. On the other hand, limited investigatory procedures in our practice setting make diagnosis of vasculitis and carotid artery stenosis less often. This may account for preponderance of hypertension as the sole risk factor of stroke in these young individuals. The results of our study also showed predominance of male over female stroke patients. This may be a reflection of prevalence of stroke in both sexes in our environment. Previous studies in Nigeria had shown that males are more afflicted with stroke than females.[15, 16]

Dilated heart chambers with spontaneous echo contrast and RHD were common CSE in our patients. RHD is still a major problem in our environment and patients often present late because

Table 3: Comparison of Echocardiographic Findings in Stroke Patients without CSE and Controls

Variables	Patients without CSE	Controls	P-value
Number	97	90	
Age (years)	57.2 ± 13.5	55.4 ± 12	0.43
RVD (mm)	16.1 ± 5.8	12.6 ± 4.6	0.001
LVDD (mm)	46.2 ± 8.4	47.3 ± 6.5	0.001
IVSD (mm)	14.5 ± 3.2	10.2 ± 1.2	0.001
LVDS (mm)	12.7 ± 2.0	9.7 ± 1.2	0.001
LVDS (mm)	31.7 ± 9.7	30.5 ± 5.4	0.001
Ef (%)	64.4 ± 9.9	72.2 ± 8.1	0.001
FS (%)	35.2 ± 5.0	35.8 ± 7.8	0.001
LVMI (g/m2)	181.6 ± 47.5	109 ± 32	0.001
AOD (mm)	32.5 ± 5.0	29.5 ± 4.0	0.001
LAD (mm)	36 ± 6.9	32 ± 4.5	0.001
RWT	0.57 ± 0.13	0.31 ± 1.2	0.001

Values are mean ±SD.

CSE, cardiac source of embolus; RVD, right ventricular dimension; LVDD, left ventricular dimension in diastole; IVSD, interventricular septal thickness in diastole; PWD, posterior wall thickness in diastole; EF, ejection fraction; FS, fractional shortening; LVMI, left ventricular mass index; AOD, aortic dimension; LAD, left atrial dimension; RWT, relative wall thickness.

of poor access to facility for adequate diagnosis and cardiac surgery.[17] Such patients are managed medically even in the presence of critical valvular lesions thereby increasing the risks of cardiac arrhythmias and thrombus formation.[18] Patients who have had cardiac surgery such as valve replacement often have the challenge of anti-coagulation monitoring as exemplified by one of our patients with artificial aortic valve.[19]

Furthermore, haematological investigation to determine disorders of coagulation causing intra-cardiac thrombus is a major challenge. One of the patients with bi-ventricular thrombi and pulmonary thrombo-embolism had no apparent structural heart disease; and we wanted to assay his homocysteine, anti-thrombin III, protein S and C but this was not feasible. Congenital heart disease and left atrial myxoma were other structural heart diseases identified in our subjects. These also need anticoagulation and cardiac surgery to treat and prevent reoccurrence of stroke.

Stroke is a recognized complication of HIV infection. Two of our patients were HIV positive but echocardiographic assessment confirmed atrial septal defect in one and the other had normal test. A previous study among young HIV positive stroke patients in Kwazulu-Natal, South Africa had suggested no causal relationship between individual status and etiology of cerebrovascular disease.[20]

The echocardiographic parameters in patients without CSE were deranged when compared with the controls (Table 3). The differences between these patients and the controls may be due to compensatory neuro-hormonal alterations in systemic hypertension as majority of them had systemic hypertension as the risk for stroke.[21, 22] The LVMI, AOD, LAD and RWT were significantly higher in the patients than controls. A high RWT (≥0.45) is a surrogate for left ventricular geometric pattern (concentric LVH) associated with worse cardiovascular outcome.[23] Initial evaluation in hypertensive individuals should include echocardiography for total risk quantification and those who have LVH need to be treated aggressively in order to reduce incidence of cardiovascular events.[24]

In conclusion, potential CSE was identified in 23.0% of our patients. In young patients who have clinical signs suggesting the heart as a potential CSE, the threshold for echocardiographic evaluation should be low. However, there is a need for rationalization of request for echocardiography in older patients without cardiovascular signs.

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Duality of Interest

There were no external sponsors and no conflict of interest whatsoever. The research was funded from contribution of the members.

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