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Echocardiography in stroke: a cross sectional study from central Nepal

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ABSTRACT

Introduction: Stroke is an important cardiovascular disease with significant morbidity and mortality. Since the treatment is not much rewarding and mostly limited to use of anti-platelets, unless highly sophisticated neurological services is available, prevention is the paramount of importance in reducing the disease burden. The heart disease and stroke are interrelated in various ways. Echocardiography as a tool for structural and functional assessment of heart can reveal underlying abnormalities leading to stroke. We conducted an echocardiographic study to assess such abnormalities in a group of stroke cases.

Materials and Methods: A cross-sectional study was designed. A total of 105 subjects diagnosed as a case of stroke based on CT scan brain and referred for echocardiography, were selected and details of echocardiographic assessment of the structure and function of their heart were recorded. Unstable and severely ill subjects, and subjects with poor transthoracic acoustic windows were excluded from the study. Only 84 cases were included in the final analysis. Various echocardiographic abnormalities in these subjects were analyzed. Findings were reported as percentages or in absolute numbers.

Results: Mean age was 64±12 years, ranging from 26 years to 84 years. Male to female ratio was 2.5:1. Major significant echocardiographic findings in stroke subjects included: LV hypertrophy (68%), Sclerotic and calcific changes of aortic valves (64%), Mitral regurgitation (40%), Aortic regurgitation (28%), Reduced ejection fraction (30%), Dilated LA (10%), Dilated aorta (6%). Other abnormalities recorded in stroke cases included mitral stenosis, mitral valve prolapse, patent foramen ovale, spontaneous LA contrast, and LA thrombus. Only 20% stroke cases had normal echocardiographic findings.

Conclusion: Various echocardiographic abnormalities including LV hypertrophy and atherosclerotic changes of aortic cusps were quite common in stroke subjects. These factors might have putative role in strokes. Early recognition of these abnormalities and initiation of treatment and preventive measures can be crucial for stroke prevention.

Keywords: Stroke, Heart disease, Echocardiography, Left ventricular hypertrophy

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INTRODUCTION

Cardiovascular Disease (CVD) has emerged as the single most important cause of death worldwide. The major CVDs, namely coronary heart disease (CHD) and stroke are the leading causes of mortality and morbidity. In 2010, CVD caused an estimated 16 million deaths and led to 293 million disability-adjusted life-years (DALYs) lost[1] and accounted for approximately 30% of all deaths and 11% of all DALYs lost that year. Among the major CVDs, CHD was on the top and accounted for 13.3% of all deaths worldwide and second largest cause of death was stroke, at 11.1% (equally split between ischemic stroke and hemorrhagic and other non-ischemic forms of stroke). An estimated 12.9 million people died from CHD and stroke, which together accounted for nearly a quarter of all deaths worldwide in 2010.[2] The situation is worse in developing countries. Compared with developed countries, it is reported that the developing countries have sevenfold higher disability adjusted life years (DALYs).[3] The World Health Organization estimates that nearly 54% of deaths and 44% of morbidity in the South Asian region are due to non-communicable diseases (NCDs).[4] In reference to Nepal, although the current trends shows increase in the burden of non-communicable diseases, details data on stroke is minimal. The Jaya Stroke Foundation, a local non-governmental organization, estimates that 50 000 people per year are afflicted with stroke, with 15 000 people dying from stroke annually.[5]

In addition to the direct mortality contribution as the first and fifth leading causes worldwide, heart disease and stroke result in serious illness and disability, impaired quality of life, and colossal economic loss every year.[2] Moreover the interconnection between stroke and heart disease as common sharing of various risk factors leading to both conditions and heart diseases as a cause of stroke have made these two conditions inseparable while discussing their treatment and prevention.

Stroke is an important cardiovascular disease and broadly classified as hemorrhagic and ischemic stoke, approximately 20% are former and 80% are the later one.[6] Among the ischemic strokes, a proportion are due to in situ thrombosis and the rest are as a result of emboli either from artery to artery within the cerebral circulation or from the heart, carotid arteries or aorta. The diagnosis of a cardiac source for emboli is based to some degree on the clinical presentation and the results of computed tomography or magnetic resonance imaging,[7] but largely on the findings on echocardiography. Studies based on transthoracic echocardiography have suggested that approximately 15% of TIAs and 15-35% of cerebral infarcts are cardiac in origin[8] while trans-esophageal studies suggest figures of at least 50% and up to 83%.[9] Some echocardiographic abnormalities, however, are controversial or even spurious causes of stroke – for example, mitral valve prolapse, atrial septal aneurysm, patent foramen ovale or mitral annular calcification and degenerative disorders. The role of echocardiography in patients suspected of suffering a cardiac embolus must therefore be examined critically.

As the management of stroke is not much rewarding and limited to the use of anti-platelets, supportive care and physiotherapy, the prevention is the paramount of importance in reducing the disease burden. Moreover, the thrombolysis in stroke is not available for all and has many limitations. The heart disease and stroke are interrelated in various ways. Echocardiography as a tool for structural and functional assessment of heart can reveal underlying abnormalities leading to stroke. We conducted an echocardiographic study to assess such abnormalities in a group of stroke cases.

MATERIALS AND METHODS

A cross-sectional study with prospective enrollment of study subjects was designed. The ethical clearance from Institutional Review Committee was sought and verbal consent for the anonymous data collection was taken from all enrolled subjects. This study was conducted in Bharatpur Hospital, a general tertiary level referral hospital with 600 beds and having major departments and specialist services. All the subjects diagnosed as a case of ischemic stroke

based on clinical presentation and CT scan brain, and admitted to the medical ward were enrolled prospectively over 6 months from January 1, 2016 to June 30, 2016. Subjects were enrolled from inpatient department and detail clinical evaluation was carried out. Unstable and severely ill patients, subjects with end stage diseases such as renal failure, heart failure, liver failure, subjects with GCS equal or less than 8 and subjects with poor transthoracic acoustic window were excluded from the study. Detail demographic data and data on CV risk factors were noted. Comprehensive echocardiographic assessment with a focus to establish the cardiac cause of stroke and cardiac manifestation due to CV risk factors and systemic atherosclerosis was carried out. A well-qualified and experienced cardiologist had performed all the Echocardiography by using a dedicated echocardiography machine, Toshiba Nemio 10 Ultrasound Machine (Japan). Details on demographic data and echocardiographic findings including structural and functional analysis of each subjects were collected in a proforma. Final results were reported as percentage and means with standard deviation as appropriate. Statistical analysis was conducted in Word Excel 2010.

RESULTS

Out of 105 stroke cases evaluated 21 subjects were excluded from the study. Among excluded, 5 cases were severely ill due to other comorbid infective conditions, 5 cases had low GCS, 3 cases had renal failure, 2 cases had heart failure NYHA IV, 3 cases had poor acoustic window due to COPD, pectus excavatum, and severe kyphosis (one in each group). Other 3 cases were excluded because of incomplete studies. Eighty-four subjects were included in the final analysis. Their age distribution is shown in figure 1.

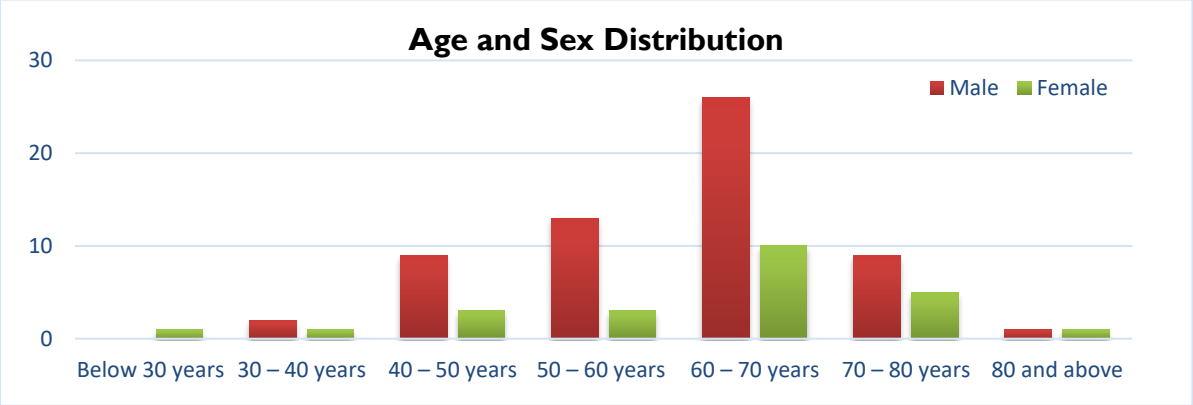

Figure 1. Age and sex distribution of subjects

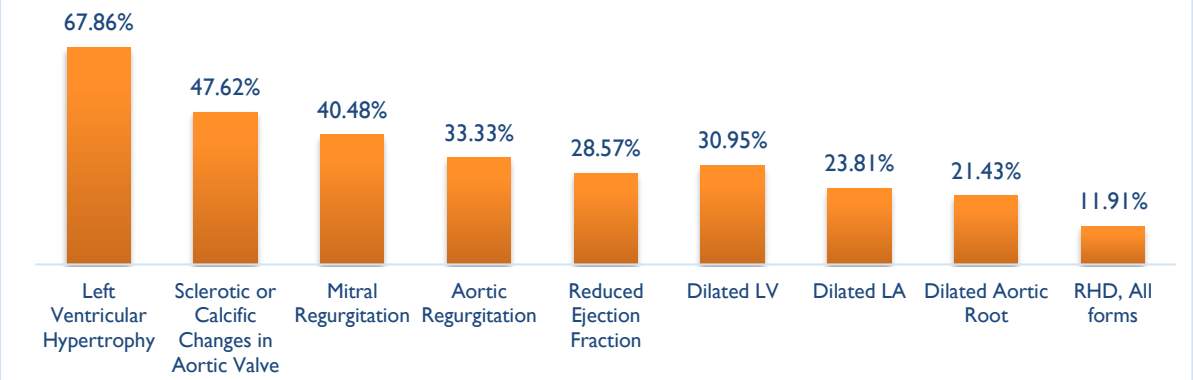

Figure 2. Major echocardiographic abnormalities in study subjects

Mean age was 64±12 years, ranging from 26 years to 84 years. 36% subjects were from 60-70 years age group. Male to female ratio was 2.5:1. Out of 84 cases, 8 were below 45 years of age and 2 were octogenarians. Eighty percent subjects had abnormal echocardiographic findings. Nearly 70% subjects had LV diastolic dysfunction (Figure 2 and 3)

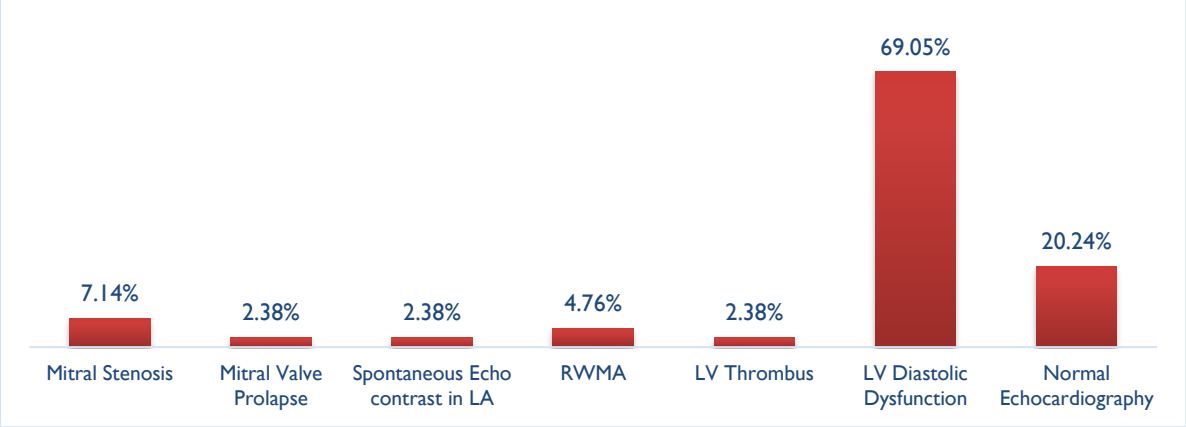

Figure 3. Minor echocardiographic abnormalities in study subjects

The details on major echocardiographic findings in stroke subjects are depicted in the figure 2. Major findings included LV hypertrophy (68%), Sclerotic and calcific changes of aortic valves (64%), Mitral regurgitation (40%), Aortic regurgitation (28%), Reduced ejection fraction (20%), Dilated LV (18%), Dilated LA (10%), Dilated aorta (6%). Other minor abnormalities recorded in stroke cases (Figure 3) included rheumatic valvular disease including mitral stenosis, mitral valve prolapse, spontaneous LA contrast and LV thrombus. Patent foramen ovale, inter-atrial septal aneurysm and congenital diseases were not recorded in our study. Only 20% stroke cases had normal echocardiographic findings.

DISCUSSION

Stroke patients tend to have various echocardiographic abnormalities related to the structure and function of the heart. In this study, nearly 80% stroke cases had some abnormalities that may have direct or indirect role in the pathogenesis of stroke. Although the direct relationship between stroke and some of these abnormalities cannot be established, these abnormalities might indicate either the presence of various CV risk factors or the structural changes due to these risk factors.

Echocardiography might be useful in establishing a direct source of emboli, for example, vegetation, myxoma, thrombus or spontaneous echo contrast in cardiac chambers. This is more important in stroke in young. Studies have shown that a left atrial myxoma may be a cause of strokes in up to 1% patients aged below 50 years of age,[10] and an embolic event can be a presenting feature in up to 15% of patients with endocarditis.[11] In our study, we were unable to record the cases of vegetation and LA myxoma. But there were 2 (2.38%) cases with LV thrombus and 2 (2.38%) cases with spontaneous echo contrast, which may have direct role in strokes. More usually, echocardiography identifies a condition with a known risk of emboli, for example, mitral stenosis may be the underlying cause of cerebral infarction even if a thrombus cannot be imaged. The thrombus might be beyond the resolution of the technique or might already have embolised. In our study, there were 6 (7.1%) cases of mitral stenosis. Among direct source of emboli, dilated cardiomyopathy is also an important condition and studies has shown 5% risk of stroke per year regardless to left ventricular thrombus identification on echocardiography.[12] In our study, there were 24 (28.57%) cases with reduced ejection fraction and 26 (30.95%) cases with LV chamber dilatation, some of them might be the

cases of dilated cardiomyopathy, either primary or secondary due to coronary artery diseases.

As the stroke and heart diseases are interlinked in many ways, echocardiography can be an important tool to establish these relationships. First, these two conditions share common risk factors and biology of pathogenesis. The common risk factors such as hypertension, diabetes, smoking, dyslipidemia, obesity, physical inactivity etc. create endothelial dysfunction leading to progression of atherosclerotic process in blood vessels and independently can lead to coronary heart disease and cerebrovascular disease. This is the usual scenario where the same process, atherosclerosis affects the underlying blood vessels, causes progression of fatty streak in vessels to plaques with subsequent ischemia in corresponding feeding areas of coronary arteries and cerebrovascular vessels and manifests as various forms of coronary heart diseases and cerebrovascular diseases respectively.[13] This sort of manifestation is more common in elderly population and in population with multiple CVD risk factors.[13,14] Various echocardiographic abnormalities such as left ventricular hypertrophy, dilated aortic root, dilated left atrium, mitral regurgitation can be secondary due to long standing hypertension.[15] Similarly, the regional wall motion abnormalities, chamber dilatation, various regurgitations, sclerotic changes in aortic valve, thrombus in chambers can be a part of systemic atherosclerosis and concurrent coronary artery disease.[16] Our study shows nearly 68% subjects had left ventricular hypertrophy and nearly 48% had sclerotic changes in aortic valve. The rates of mitral and aortic regurgitations were above 40% and 33% respectively.

In addition to the formation of in situ thrombosis in cerebral vessels, stroke can be due to detached thrombus from carotid arteries and spreading in distal arteries, causing their block as emboli.[17] This can be established with the help of Doppler study of carotid arteries. In current study we had focused only on echocardiography and Doppler study reports were not analyzed. But in such cases also, echocardiography can reveal the evidence of systemic atherosclerosis in the form of sclerotic changes in aortic valve with or without regurgitation and dilated aortic root.[18] In our study such sclerotic changes were seen in 48% subjects. Aortic regurgitation was recorded in one out of three cases, but the regurgitation was not related to only sclerotic process. Aortic root dilatation was seen in 21% subjects.

In some situation, the diseased vessels structurally might become weak and can develop various malformations in vessel wall. Similarly some vascular anomalies, inborn or acquired, can create weak area in the form of malformations and aneurysms and can undergo tear or rupture leading to hemorrhagic stroke if it happens in cerebral vessels. Rapid rise in blood pressure, or withdrawal of regular antihypertensive medicine can be a precipitating factor or precursor in such situation.[19] As a continuum of the same systemic process the atherosclerosis can also affect valvular apparatus in the form of sclerotic changes and micro or macro emboli detached from these valve leaflets and cusps can cause embolic stroke as well.[18] Although the sclerotic changes could be a direct cause of stroke, there are problems with definition of aortic atheroma and sclerosis. Some authors had reported any degree of aortic atheroma giving an incidence up to 33% in stroke cases.[20] We have studied the sclerotic changes in aortic valves assessed in transthoracic echocardiography and among our stroke cases nearly 48% had such sclerotic changes in aortic valve. Similar incidence (48%) of aortic valve sclerotic changes as in our study were also reported in a study on trans-esophageal echocardiography of stroke subjects by Nihoyannopoulos et al.[21]

Another interrelation between heart disease and strokes comes as complications of former condition having structural and functional alteration of the heart. Heart disease can manifests as thrombus in enlarged chambers or akinetic walls or vegetation in various valvular leaflets and cusps due to certain infective or non-infective causes, which can detach and migrate to cerebral vessels and causes stroke.[16,17] In our study, nearly 29% had reduced ejection fraction, mostly with LV global hypokinesia and few with regional wall motion abnormalities (5%).

Dilatation of LV, LA and aortic root were seen in 31%, 24% and 21% subjects respectively. These changes could be secondary due hypertension, coronary artery disease and systemic atherosclerosis or other non-coronary heart diseases such as rheumatic heart diseases. Their putative role in stroke cannot be denied. Two subjects (2.38%) had noted to have LV thrombus along with dilatation and two cases (2.38%) had spontaneous echo contrast in dilated LA, these findings can be a direct source of emboli. In some study the incidence of LA spontaneous echo contrast was shown 20% in stroke and 5% in control subjects.[22] Thrombus was found in 10% with stroke compared with 3% in controls and in some it had coexisted with spontaneous echo contrast. As spontaneous echo contrast may varies with gain settings and the carrying frequency of the probe, it is relatively non-specific finding and its variation in different study should be taken easily.

Nearly 12% subjects in our study had rheumatic heart disease, some of the mitral and aortic regurgitations and chamber dilatations were related to RHD and more than 7% had mitral stenosis as well. RHD is an established cause of stroke, especially in young strokes.[23] Other non-rheumatic valvular disease, such as degenerative valvular disease and mitral valve prolapse and their association with stroke is controversial. In our study, mitral valve prolapsed was noted in 2 (2.38%) cases. Mitral valve prolapse may not be the genuine cause of stroke, in some study it has been reported in up to 40% of ischemic stroke subjects,[24] in most studies it is less common and in some there were no cases at al.[25] In a large study[26] the incidences in stroke cases and controls were the same 5%. Stroke in MVP is low and can be attributed to other associated factors such as atrial fibrillation.[27,28] Other degenerative valvular diseases such as mitral annular calcification may be related to stroke,[29] however the cause is not clear. In our study, we were unable to delineate non-rheumatic valvular heart disease.

Few studies have shown association between cryptogenic strokes and patent foramen ovale,[30,31] however, we did not come across any cases of patent foramen ovale in our study. Among other unusual causes of stroke, the inter atrial septal aneurysm has been discussed in literature,[20] but our study did not show such findings as well. Apart from these heart conditions, certain congenital heart diseases and thrombophilic disorders are also associated with strokes, but we were unable to record such cases in our study. In our study, nearly 69% stroke subjects had LV diastolic dysfunction, but its role and significance in stroke is unknown. Another important finding in current study is that 20% subjects had totally normal echocardiographic study.

This study has certain limitations inherent to its study design as an observational cross-sectional and small sample size. Similarly, a single cardiologist had carried out all the echocardiographic assessments and inter-observer and intra-observer variability were not studied. In addition, no comparison with the similar findings in healthy subjects was done. Therefore, further study with prospective enrollment of study subjects of large sample size and comparison with age and sex matched healthy controls would be of great help in further clarifying its findings.

CONCLUSION

Our study recorded that echocardiographic findings such as left ventricular hypertrophy, sclerotic changes in aortic valve, aortic and mitral regurgitations, LA, LV and aortic root dilatations, reduced LV systolic function and rheumatic heart diseases including mitral stenosis and regurgitation were common in stroke cases. Other findings, such as global and regional wall hypokinesia, mitral valve prolapse, LV thrombus and spontaneous echo contrast in LA were less common, while patent foramen ovale, inter-atrial septal aneurysm, mitral valve prolapse, mitral annular calcification were unusual and rarely encountered. This suggests that the early detection of such abnormalities and appropriate preventive measures could play a significant role in the prevention of stroke. It also signifies that the routine echocardiographic assessment of subjects having CV risk factors is essential.

COMPETING INTEREST

The authors declare that there are no competing interests regarding the publication of this paper.

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