

Prevalence of Atheromatous Aortic Plaques in Patients with Ischemic Stroke Using Transesophageal Echocardiography

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Abstract

Background- Nowadays, the pathogenic role of atherosclerosis of the aorta in embolic stroke is well understood. TEE continues to play a prominent role in the evaluation of patients with stroke and finding the source of emboli. TEE shows that the incidence of strokes presumed to have a cardioembolic origin varies from 13-40% and that atherosclerotic disease of the aortic arch has been found in 40-60% of cerebral emboli. We investigated the prevalence and severity of atherosclerotic aortic plaques in patients with embolic stroke to ascertain their role as a risk factor for ischemic cerebral events.

Methods- Using TEE, we performed a cross-sectional study of the frequency and severity of aortic plaques in 60 patients admitted with ischemic stroke. Major atherosclerotic risk factors and the presence of coronary artery disease and carotid plaques were also surveyed.

Results- TEE detected at least one potential source of embolism in 48 patients, aortic plaques in 29, carotid plaques in 11 and cardiac pathologies in 19. Atrial fibrillation and valvular heart diseases (mostly mitral stenosis) were the most prevalent cardiac anomalies. The remaining 12 patients were regarded as cryptogenic cases. Fifty patients had at least one major risk factor of CAD. The majority of the plaques were detected in the arch and ascending aorta; of these 13.7% were complicated (grade III). There was a significant relation between aortic plaques and hypertension, male sex and CAD. Aortic calcification in CXR was strongly predictive of aortic plaques but not a sensitive criterion.

Conclusion- Abnormalities are commonly found by TEE in patients with stroke. The results indicate a strong, independent association between atherosclerosis of the aorta and risk of stroke. TEE should be considered

(Iranian in patients after stroke as a routine test and ultimately for prophylaxis and treatment of stroke

Heart Journal 2005; 6 (1,2): 72-77.

Key words: transesophageal echocardiography (TEE) Æ atheromatous aortic plaque Æ ischemic stroke.

Stroke is the third cause of mortality in the world.¹ Investigations as to the underlying cause of ischemic stroke reveal cardioembolic causes in 13-40% but fail to define any cause in about 30% of cases.² Until recently, atherosclerosis of the aorta was not regarded as a potential source of emboli.³

Postmortem studies on stroke patients have shown atherosclerotic aortic plaques in 40% of cases.⁴

The advent of transesophageal echocardiography (TEE) has made it possible to detect aortic plaques and reveal their morphologic characteristics with the risk of stroke and other vascular events.⁵

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In particular, atherosclerotic disease of the aorta may simply be a marker for general atherosclerotic disease, as coronary artery disease (CAD) or carotid plaques.⁶

The aim of our study was to determine with TEE the frequency of plaques in the aorta in patients admitted with brain infarction.

Methods

This was an observational, analytic study with a cross-sectional design. Sixty-five patients with ischemic stroke who were hospitalized in the neurology ward between 2003 and 2004 were enrolled in the study. Five patients were excluded because of premature termination of TEE. The diagnostic criteria for ischemic stroke were the presence of abrupt neurological deficit accompanied by territorial infarction pattern visualized by either brain CT scan or MRI. A complete patient history and atherosclerotic risk factors were recorded. In addition, a careful physical examination of each patient was performed on admission. Routine hematologic and biochemical tests, urine analysis, chest X-ray and 12-lead ECG were obtained. Each patient underwent an examination of carotid arteries by a radiologist using duplex sonography. Written consent forms were taken from all the patients. Within two weeks of the onset of acute symptoms, TEE was performed for all the patients after local oral and pharyngeal anesthesia with 2% lidocaine spray, using a 5MHz multiplanar probe on a Ving Med device. All the images were recorded on videotapes for further evaluation. Whenever necessary, the patient was sedated with 1-3 mg IV midazolam. Agitated saline was injected to all the patients to evaluate any intracardiac shunts. TEE examination included visualization and evaluation of valves, chambers and aorta. Intraortic plaques were described with regard to their location as ascending, arch and descending, and also to their severity as follows: Grade I = mild irregularity and intimal thickening,

Grade II = moderate irregularity and intimal thickening <5 mm and Grade III = severe irregularity and intimal thickening >5 mm, and mobile, protruding, ulcerated or calcified plaques.

Statistical Analysis

Quantitative variables were shown as mean ± SD. T-test was used for their comparison. To compare qualitative variables, we used Chi-square for 2×2 tables and ANOVA (F-test) for more complex tables. Primary significant differences were further assessed by the Post Hoc (Tukey method) test. All the calculations were performed by SPSS 10.0 package. Statistical significance was set at p< 0.05.

Results

We examined sixty patients (35 males, 25 females) 27-75 years of age (mean age 55.7±8.8). Fifty patients (83%) had at least one of the major risk factors for atherosclerosis; of these 23 (38%) had history of hypertension (HTN) irrespective of their treatment status, 17 (28%) had hyperlipidemia, 14 (23%) were diabetic, 24 (40%) had history of previous or recent cigarette smoking and 7 (13%) had history of CAD in their first-degree relatives (See Table I).

Table I. Demographic and paraclinical variables in the study population.

No. of patients	60
Age (yr , mean ± SD)	55.7 ± 8.81
Range of age (yr)	27 - 75
Sex (male/female)	35/25 (58% / 42%)
Hx. of CVA / TIA	4 (6.7%)
Hx. of IHD	11 (18.3%)
Atherosclerosis risk factors	50 (83%)
Hypertension	23 (38.3%)
Hyperlipidemia	17 (28.3%)
Diabetes Mellitus	14 (23.3%)
Cigarette Smoking	24 (40%)
Family History	8 (13.3%)
Cardiac findings by TEE	19 (31.6%)
Aortic calcification in CXR	10 (16.6%)
Aortic plaque by TEE	29 (48.3%)
Carotid plaque by Duplex sono	11 (18.3%)
Lab data (mean ± SD)	
FBS	111.5 ± 26.7
BUN	27.2 ± 7.1
Cr	1.03 ± 0.2
TG	210.3 ± 77.4
T.Chol	198.9 ± 57.2
HDL	58.5 ± 9.1
LDL	116.6 ± 52.4

In 10 patients (16%), there was calcification of parts of the aorta in chest X-ray; 9 of them also had aortic plaques in TEE (Pearson chi-square = 0.003). As to the cause of stroke, we found cardiac sources in 31.6%, carotid disease in 18.3% and aortic plaques in 48.3%. Even with the above-mentioned investigations, no cause could be found in 12 patients (20%). Of all the cardiac sources, 9 patients were in atrial fibrillation rhythm, 10 had valvular heart disease (all of them mitral stenosis), 3 had left atrial appendage clot, one had left ventricular clot (in a patient with extensive anterior myocardial infarction), two had patent foramen ovale and the remaining two had atrial septal aneurysm. Spontaneous echo contrast (smoke) was observed in six cases with mitral stenosis and also in the patient with extensive anterior myocardial infarction. Severity, frequency and location of the carotid artery disease are shown in Fig.1.

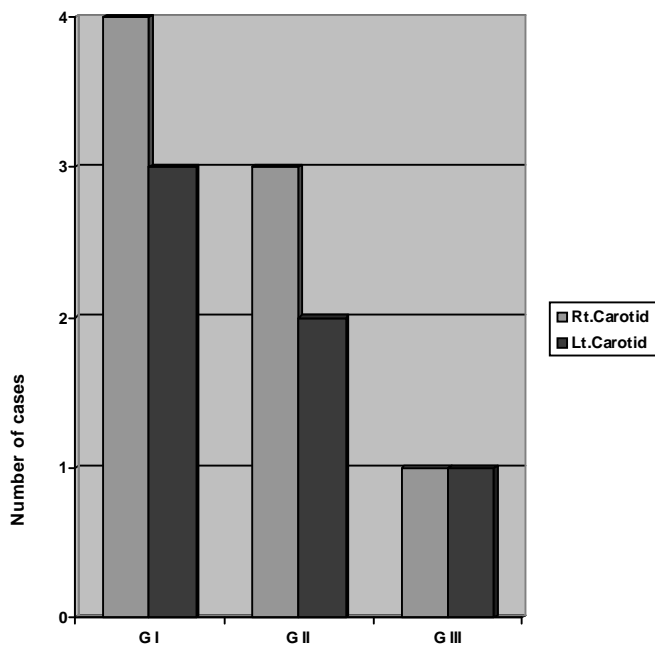


Fig.1. Frequency and severity of carotid plaques.

Carotid plaques were detected in both left and right carotids simultaneously in three patients. Aortic plaques were detected in 29 (48.4%) patients (Fig.2)

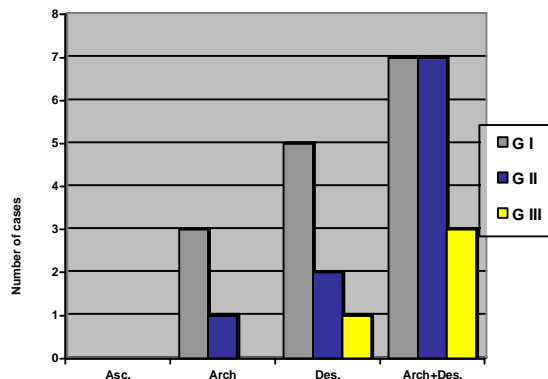


Fig. 2. Severity and location of aortic plaques.

As it is seen, simultaneous disease in both the arch and descending portion of the aorta is more frequent than other segments, so the frequency of plaques in the descending aorta, either alone or with other areas, is as high as 86%. The severity of aortic plaques was G I = 52%, G II = 34% and G III = 14%. Age distribution of aortic and carotid plaques is shown in Figs.3 and 4.

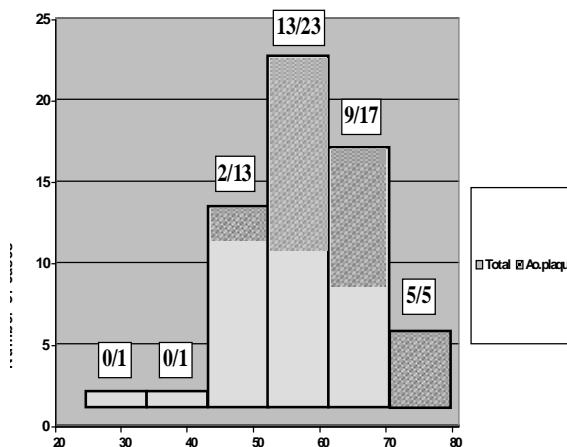


Fig. 3. Age distribution of aortic plaques.

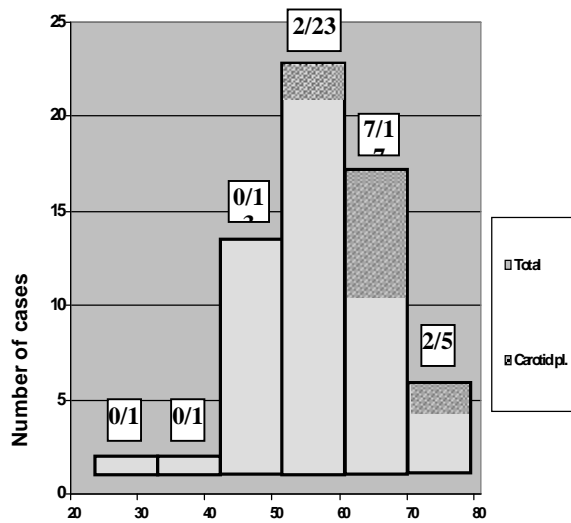


Fig. 4. Age distribution of carotid plaques

Aortic plaque prevalence was significantly different between the males and females (21% vs. 8%, respectively, $p = 0.03$). A significant association between the major atherosclerotic risk factors and aortic plaques was found only for HTN ($p = 0.002$). Ten of the 11 patients with history of CAD also had aortic plaques ($p = 0.003$), but the association was not significant between carotid and aortic plaques.

Discussion

Atherosclerotic disease is inherent in the aging process. In view of the high medical and economic burden of stroke, it is prudent to search for its causes to plan for appropriate treatment and prophylaxis. TEE is a non-invasive procedure that poses little or no risk to the patient, and its accessibility, ease of use and low cost has made it a useful investigative tool to evaluate cardiovascular sources of embolism. It has the potential to detect the lesions in the aorta more accurately than plain radiography,⁷ computed tomography,⁷ angiography^{7,8} and, of

course, TTE.⁹ Plaques located proximal to the ostium of the left subclavian artery have been found in 60% of patients 60 years of age or older with ischemic stroke.¹⁰ In our study, most of the lesions were found in the descending and arch of the aorta, whereas the ascending aorta appeared to be the least prevalent site of atherosclerosis involvement. This finding is consistent with previous necropsy and echocardiographic studies.^{11,12} It has been proposed that the lack of vasa vasorum in the descending aorta makes this segment vulnerable to the atherosclerotic process, and this could be a probable cause for this difference in the distribution of plaques.¹³ Several studies have shown that aortic plaques are highly associated with the presence of CAD, with acceptable positive and negative predictive values.^{14,15,16} The present study also showed a high association between the history of CAD and the presence of aortic plaques in patients with stroke. Consequently, it is reasonable to routinely perform TEE at least in patients with a history of CAD. Amarenco et al. showed the significance of plaque morphology in risk stratification for overall vascular events, especially ischemic stroke, and their mortality. Several morphologic characteristics of plaques have been proposed to be associated with increased risk of stroke. The most increased relative risk is attributed to the plaques with a thickness of more than 4 mm, although ulceration, lack of calcification and the presence of hypoechoic pattern in plaques are also markers of increased risk.¹⁷ The term “vulnerable” refers to these high risk, unstable plaques, which are most prone to rupture and thrombosis. In all the previous studies with TEE for the evaluation of stroke patients, echo was performed only in those who exhibited no evidence of carotid atherosclerotic disease,¹⁸ although it is possible to find atherosclerotic plaques both in the aorta and the carotid arteries.

Thus in our study, we did not exclude those with carotid plaques in order to be able to find such co-morbidities. A negative TEE examination does not rule out the possibility of cardiogenic embolism, and even if a definite abnormality such as thrombosis or vegetation can be identified, this does not prove that the abnormality is the actual source of the embolism.⁸ According to the present knowledge, there is no general agreement for continuing the evaluation by TEE if another reasonable source of stroke has been detected. Although finding such aortic plaques in these patients may not change the therapeutic management, these plaques are highly valuable for determining the prognosis and recurrence rate of stroke and other vascular events, e.g. renal and peripheral emboli. In other words, it is unwise to accept a patent foramen ovale, atrial septal aneurysm or even a low risk carotid plaque in an old age stroke patient with a history of CAD. Our study showed the association of aortic plaques and major risk factors only for HTN, but it is acceptable to find this association also for other risk factors by choosing a larger sample volume and a more precise study design. Meanwhile, it is evident that diagnosis and prompt modification of these risk factors can be highly effective in reducing the incidence and mortality of any vascular events- as it has been so in recent years- generally speaking, better primary and secondary prevention. The aorta is recognized as the first and most severe site for atherosclerosis, with lesions occurring there long before one is able to detect atherosclerotic plaques in coronary or carotid arteries.¹⁴ With respect to the senile process of atherosclerosis, it is logical to find plaques more prevalently in older ages. The peak prevalence for aortic and carotid lesions is in the 6th and 7th decades, respectively. This can be explained by the earlier beginning of

atherosclerotic processes in the aorta than in the carotid artery. The frequency of aortic plaques in the 8th decade (100%) is significantly more common than carotid (40%) plaques. It can be associated to a bias in patient groups because of more frequent mortality in patients with carotid lesions compared to aortic ones.

Conclusion

Atherosclerotic disease of the aorta has recently been considered as a source of emboli. It is highly prevalent in stroke patients, so the evaluation of the aorta by TEE could be included in the work up of all these patients. A further aspect of our research relates to the therapeutic consequences of aortic plaques; therefore, it is advisable to conduct prospective cohort studies to ascertain the natural course of these plaques and plan appropriate therapeutic modalities.

Acknowledgements

Special thanks are due to the following dear colleagues in Dr. Shariati Hospital: Soltanzadeh M.D., professor of the neurology department, assistants of the neurology department, assistants of the cardiology department, nurses and staff of the cath. lab and echocardiography ward and the medical engineering ward.

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