Original Article

Usefulness of transoesophageal echocardiography in ischaemic stroke

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Abstract

Background: Aorta can be a source of embolic stroke, and study of aorta can sometimes give us insight into the atheromatous process going on in the vascular tree. Another important source for emboli can be the left atrium and its appendage. Transoesophageal echocardiography (TEE) is useful in studying the different parts of aorta, mitral valve apparatus, interatrial septal identification and measuring patent foramen ovale, aneurysmal atrial septum and myxoma of the left atrium.

Methods: We retrospectively studied the TEE findings in 500 patients with ischaemic stroke seen at CARE Hospital, Nampally, Hyderabad, Telangana state from their care records.

Results: There were 362 males (male: female = 2.6). Different grades of abnormalities were seen in the aorta, more commonly in the arch and descending aorta. The atrial septal abnormalities were seen in 18 cases. Clots or masses within the atria or ventricles were seen in 22 patients. The mitral valve was more often diseased in ischaemic stroke patients, though aortic valve disease or even multiple valve disease was also seen in many patients, and the valve disease was of different grades.

Conclusions: TEE was useful in identifying an embolic source in 10% of patients and helped in initiating anticoagulation. It was also useful in identifying complex aortic atheroma in another 92 (18.4%) cases and helped in starting different antiplatelet drug combination or anticoagulation. TEE helped in identifying the pathogenesis of strokes with difficult to identify mechanisms.

Keywords: Atheromatous plaques, embolic stroke, stroke, transoesophageal echocardiography

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INTRODUCTION

Stroke is a devastating disease. The mechanisms are varied – atherothrombotic, lacunar stroke, embolic, inflammatory or sometimes (in nearly 30%–40% cases) cryptogenic as per Trial of Org 10172 in Acute Stroke Treatment (TOAST) classification.[1] The embolic strokes are most commonly secondary to atrial fibrillation, which accounts for nearly two-thirds of cases. There is one significant source of emboli which is often not evaluated fully during stroke workup before concluding as cryptogenic stroke, and that source is the aorta. The aorta and its different parts are difficult to inspect and many a time a diseased aorta can complicate a coronary artery

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bypass graft surgery (CABG) with a stroke on the first or second postoperative day.

A second important source for emboli can be the left atrium and/or its appendage. As the anatomical location of the atrial appendage is somewhat obscure, it is difficult to identify the thrombi formed within that structure. We did a study of the aorta, the left atrium and its appendage, and the results were analysed.

Manipulation of a diseased ascending aorta during procedures can release atheromatous plaques into the circulation leading to embolic strokes. The aortic arch is the part most often affected by the atheromatous process because of its curvature and the constant jet of blood propelled into it by the heart. The disease of the aortic arch affects only the left carotid and vertebral systems. Retrograde and rotational blood flow in the thoracic aorta probably exists in all patients with systemic emboli and mobile, protruding aortic atheromas. Therefore, retrograde cerebral embolism from distal aortic plaques is theoretically possible. Aortic insufficiency may augment such retrograde flow.[2] Hence, the paradoxical reversal of flow in the aortic arch may not be of clinical importance. However, descending aortic plaques have been considered as high-risk sources for brai.[3]

Stroke Prevention Assessment of Risk in a Community study in 581 individuals had shown that cerebrovascular disease is weakly associated with aortic atherosclerosis.[4] Small atheromatous emboli may occur spontaneously or following vascular surgery, or vascular procedures. The most common target organ of these atheroemboli is brain (16%) followed by spleen (11%), kidney (10%) and pancreas (7%). Modifications in cardiac procedures can reduce the atheroembolic events and strokes in particular, in the case of aortic atherosclerosis, like off-pump procedure for CABG surgery. Similarly, the right radial arterial approach for cardiac catheterization bypasses an atheromatous aortic arch.

Besides aortic morphology, TEE is also useful in studying the left atrium, its appendage and the mitral valve apparatus. It is also useful in interatrial septal identification and measuring the patent foramen ovale (PFO), aneurysmal atrial septum and myxoma of left atrium. It is the gold standard in the diagnosis of mitral valve vegetations and is superior to transthoracic echocardiography (TTE). Atrial septal aneurysm and PFO are associated with increased frequency of cryptogenic stroke according to PFO in Cryptogenic Stroke Study wherein 100 patients were studied using TEE. It can be instrumental in decision-making in certain situations regarding surgery (in case of myxoma) or initiating anticoagulation (in case of left atrial appendage clots).

MATERIAL AND METHODS

The cases are collected from the records of our tertiary care hospital, from ischaemic stroke patients. In our centre, every ischaemic stroke or TIA patient undergoes evaluation to identify the mechanism of stroke as per TOAST classification.[1] Multiplane TEE is a part of the work-up preceded by TTE. Multiplane TEE machine (Wipro GE, Model VIVID E9 with 6 MHz probe) was used, in which the cooperative patient swallows the probe and various parameters are studied by a trained physician/cardiologist. The present study includes a total of 500 such TEE records which were analysed to identify the common observations, common abnormalities with special reference to those which can lead to identification of the mechanism of ischaemic stroke. The follow-up of these patients is not included in this study. Some of the abnormalities could change the treatment direction, especially whether to use anticoagulants or to use a different antiplatelet drug/drugs combination.

Proximal aorta was studied with its different parts as ascending aorta, arch and proximal descending aorta. The atheroma was identified whenever it was present and graded as per the standard grading system.[5] The left atrium and its appendage were identified, and it was examined for spontaneous echo contrast (SEC) or a clot (whether soft or organized) and its size. The interatrial septum was studied with reference to its integrity, presence of PFO, atrial septal defect, any procedures done earlier and presence of atrial septal aneurysm. The mitral valve morphology, vegetations or masses, interventricular septum and the left ventricle (LV) were also studied to the extent possible, and particularly any clot in the LV was noted.

RESULTS

Five hundred ischaemic stroke patients were studied. Exclusion criteria were incomplete work-up, not co-operative for TEE testing and age <20 years. Male ischaemic stroke patients were more than two times in number compared to female patients.

Different grades of abnormalities were seen in the aorta, more commonly in the arch and descending aorta

[Figures 1, 2 and Table 1]. The changes in the ascending aorta were minimal and many a time the ascending aorta did not show any abnormality [Table 1]. The atrial septal abnormalities were seen in 18 cases [Table 2]. Clots or masses were seen in 23 situations [Figure 3 and Table 3].

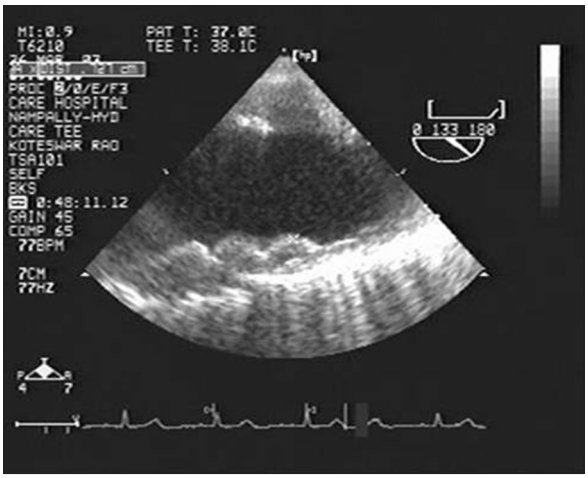

Figure 1: Grade IV atheroma on transoesophageal echocardiography

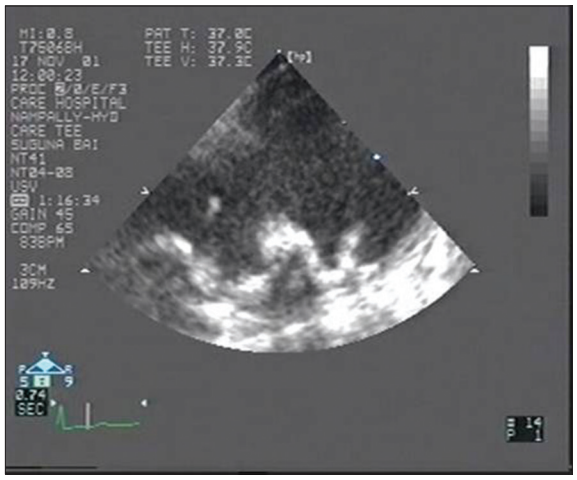

Figure 2: Grade V atheroma (mobile plaque) on transoesophageal echocardiography

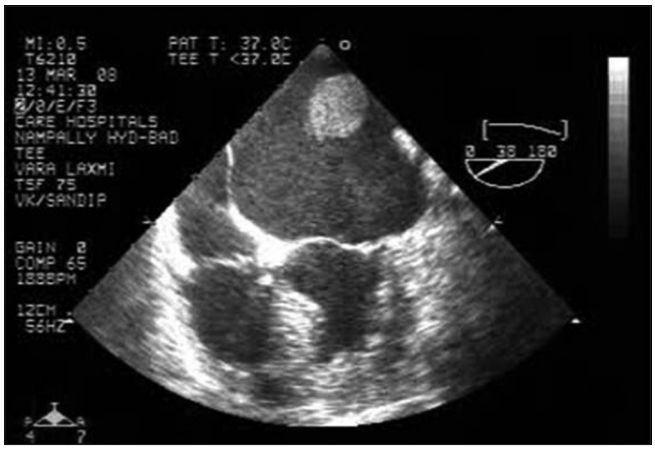

Figure 3: Left atrial clot seen on transoesophageal echocardiography

Table 1: Abnormalities in the aorta on transoesophageal echocardiography

	Normal	Grade I	Grade II	Grade III	Grade IV	Grade V
Ascending aorta	307	169	17	6	1	0
Aortic arch	16	109	181	134	50	10
Descending aorta	15	147	219	87	19	13

Table 2: Atrial septal abnormalities on transoesophageal echocardiography

Interatrial septum morphology	Number of patients
Tiny PFO at upper end of fossa ovalis	2
Tiny PFO at upper end with L-R flow	3
2 tiny PFOs at both ends of fossa ovalis	3
Tunnel PFO with L-R flow	1
ASD closure with intact patch	1
ASD closure + MVR and tiny residual L-R shunt	1
Atrial septal aneurysm	1
Permanent pacemaker	2
Intact atrial septum bulging into the right atrium	1
4 mm PFO at lower end of fossa ovalis	1
2 stretched out PFOs, each >4 mm with L-R shunt	1
1 mm PFO at upper end of fossa ovalis with L-R flow	1

PFOs=Patent foramen ovale; ASD=Atrial septal defect; L=Left; R=Right; MVR=Mitral valve replacement

Table 3: Clots within the heart on transoesophageal echocardiography

Clots within the atria or ventricles	Number of patients
Spontaneous echo contrast in the left atrium or left atrial appendage (+ to +++)	12
Left ventricular apical clot	2
Mobile soft clot at left atrial appendage	2
Organized left ventricular clot	2
Organized left atrial clot	2
Left atrial appendage clot	1
Left atrial myxoma	1
Left atrial myxoma excised	1

The mitral valve was more often diseased in ischaemic stroke patients, though aortic valve disease or even multiple valve disease was also seen in many patients, and the valve disease was of different grades [Table 4]. Aortic valve abnormalities were seen in 20 patients [Table 5]. Seventy-one patients had double or triple valve abnormalities [Table 6] in different combinations.

DISCUSSION

TEE is a safe, semi-invasive, most sensitive and widely used technique to evaluate the proximal aorta. It can be safely performed even in advanced age. In elderly patients with cardiovascular diseases, TEE plays a significant role in the decision-making process without adding any significant risk.[6] In a survey of 10,419 cases, there were 201 failures

Table 4: Mitral valve appearance on transoesophageal echocardiography

Mitral valve abnormalities	Number of patients
Trivial MR	104
Mild MR	59
Moderate MR	15
Severe MR	1
Moderate MS + severe MR	1
Moderate MS + mild MR	2
Severe MS + mild MR	11
Tight MS	1
S/P MVR, trivial MR	3
S/P MVR mild MR	2
S/P MVR severe MR (partial dehiscence of prosthetic valve)	1
S/P MVR no murmurs	1
PBMV, moderate MR + mild MS	1
MVP + mild MR	1
S/P CMV + moderate MR + mild MS	1
AML tip prolapsed, moderate MR	1

MR=Mitral regurgitation; MS=Mitral stenosis; MVR=Mitral valve replacement; PBMV=Percutaneous balloon mitral valvuloplasty; MVP=Mitral valve prolapsed; CMV=Closed mitral valvotomy; AML=Anterior mitral leaflet; S/P=Status-post

Table 5: Aortic valve abnormalities on transoesophageal echocardiography

Aortic valve disease	Number of patients
Sclerotic aortic valve	15
Sclerotic aortic valve with mild AR	3
Calcified aortic valve with mild AS + AR	1
S/P AVR, no murmurs	1

AS=Aortic stenosis; AR=Aortic regurgitation; AVR=Aortic valve replacement; S/P=Status-post

Table 6: Multiple valve abnormalities on transoesophageal echocardiography

Combined valve diseases	Number of patients
Mild MR + trivial AR	10
Trivial MR + AR	33
Mild AR + trivial MR	13
Mild MR + mild AR	5
Moderate MR + mild AR	1
Sclerotic aortic valve + mild MR	2
Sclerotic aortic valve + mild MR/TR	1
IE aortic valve	1
S/P DVR (mitral + aortic)	1
S/P MVR + TV repair	1
Mild MR + trivial AR, TR	1
Severe MR + mild TR	1
Mild TR, mild PAH, trivial MR	1

TR=Tricuspid regurgitation; IE=Infective endocarditis; DVR=Double valve replacement; PAH=Pulmonary arterial hypertension; MR=Mitral regurgitation; AR=Aortic regurgitation; MVR=Mitral valve replacement; S/P=Status-post; TV=Tricuspid valve

due to patient's non co-operation, and in 90 cases, there were minor complications.[7] Complications are uncommon and when they occur, may be due to unsuspected, preexisting oesophageal disease. No such compalication was seen in the present series. Uncooperative patients are not suitable candidates for TEE. A small portion of the aorta may not be visualized during TEE due to the 'blind spot' on account of trachea interposing between oesophagus and aorta.

Role of TEE as an investigation in every ischaemic stroke is still ill-defined. A meta-analysis including 27 studies found marked interstudy variation in the prevalence of common findings.[8] This is probably because of variation in the definition of the common findings like PFO, complex aortic atheroma or SEC. In a prospective TEE study of 84 patients in whom clinical evaluation and TTE did not prompt the introduction of anticoagulation, 32.1% patients could find anticoagulation beneficial.[9] An abnormality on TEE, although common in nearly 71% patients and more sensitive than TTE, altered the treatment protocol only in 3% of individuals in a review of 100 stroke individuals referred for assessment.[10]

In patients presenting with acute ischaemic stroke, large aortic plaques are associated with blood hypercoagulability, suggesting a role for coagulation activation in stroke mechanism.[11] The complex plaques are more likely to be associated with embolic strokes and require more aggressive management strategies. In a TEE study of 152 elderly patients with stroke, Di Tullio *et al*.[12] concluded that aortic atheroma complexity rather than size is strongly associated with ischaemic stroke in the elderly.[11] Either dual antiplatelet drug therapy or anticoagulants are useful in such situations as larger plaques are said to be more dynamic. Aortic arch endarterectomy is a risky procedure and is associated with intraoperative stroke and hence is not recommended.[13]

PFO occurs in 20%–34% of normal individuals and can be identified in many normal individuals on TEE. Its importance as a source for embolic stroke is controversial. A transthoracic contrast study making use of Valsalva manoeuvre, a sharp sniff or cough, can be used for diagnosing a right-to-left shunt, and the sensitivity ranges from 63% to 100% rather than fundamental imaging. The PFO is significant from stroke point of view only when it is more than 4 mm in diameter, associated with atrial septal aneurysm and has vegetations along its edge or with right-to-left shunt. A PFO was identified in 7 (1.2%) of our patients. A large PFO was seen in only in 2 patients and both had left to right shunt. Hence, it was difficult for it to be labelled as a cause of embolic stroke. Pelvic magnetic resonance venography or lower limb venous Doppler study can be done in such cases to identify an embolic source whenever there is a strong suspicion.

SEC in the left atrium or its appendage can be easily detected on TEE but very rarely on TTE and is an indication for anticoagulation. SEC was seen in 12 patients

in our study. It is characterized by dynamic smoke-like echoes and is mostly seen in conditions such as mitral stenosis, mitral valve prosthesis or atrial arrhythmias. These conditions are associated with enlarged left atrium, leading to stasis of blood.[14] Mitral regurgitation has protective effect against SEC. SEC is a precursor of thrombus and must be treated aggressively just like a clot. Clots in the left atrium, atrial appendage or in the ventricle are definite sources of emboli, most commonly to the brain. Anticoagulation for 3–6 months with maintenance of international normalization ratio within acceptable therapeutic limits will reduce the incidence of stroke in such cases. In resistant cases, the left atrial appendage can be excised or closed with a device.

In 205 cases, mitral valve alone was abnormal and 9 of them were already operated. Mitral valve disease is the most common of the valve diseases to produce embolic stroke. We could find postoperative complications such as prosthetic valve dehiscence with paravalvular leak, closed mitral valvotomy and balloon mitral valvotomy with recurrence of mitral valve disease in the form of stenosis coupled with regurgitation in some of our patients. Rheumatic heart disease with atrial fibrillation is commonly associated with embolic stroke, and every rheumatic heart disease patient should be diligently screened for arrhythmias. Aortic valve diseases are less commonly seen in stroke patients; but, nonetheless, several patients in our series had aortic valve disease either alone or in combination with other valve diseases. Most commonly calcified aortic valve, infective endocarditis and prosthetic valve in aortic position are associated with embolic strokes.

TEE is useful in cryptogenic stroke evaluation. It identifies cardiac findings in a large proportion of cases. There are no clear guidelines about the exact indications when to do the test after stroke; some hospitals are doing the investigation in every ischaemic stroke patient and some perform the same in a more restricted manner. In the present study, it was useful in identifying an embolic source in 10% (54 cases) of patients and helped in initiating anticoagulation. It was also useful in identifying complex aortic atheroma in 18.4% cases (92 patients) and helped in starting stronger antiplatelet drug combination or anticoagulation. It was also helpful in studying left atrium and its appendage more closely to know the diseases that can lead to embolic stroke. However, there were many more abnormalities which were found on TEE that did not necessarily change the treatment protocols but helped in identifying the pathogenetic mechanisms of strokes. Some TEE findings were coincidental and did not have relevance in the stroke pathogenesis. Hence, it is still premature to say that TEE should be done in every stroke patient, even though it has a place in the workup of ambiguous cases.

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Conflicts of interest

There are no conflicts of interest.

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