Role of Echocardiography in Patients With Stroke

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INTRODUCTION

Cardiogenic embolism is recognized increasingly as an important cause of stroke. Approximately 20% of ischemic strokes originate from (or through) the heart.[1] Cardioembolic stroke is defined as a nonlacunar stroke with the presence of a potential cardiac source in the absence of cerebrovascular disease. It is a heterogeneous entity, since a variety of cardiac conditions can predispose to cerebral embolism. It has an unfavorable outcome since it produces larger and more disabling strokes than other ischemic stroke subtypes. The availability of new diagnostic techniques, especially trasnsesophageal echocardiography (TEE) has allowed clinicians to identify cardiac sources of embolism with a very high sensitivity and specificity. Cardioembolic stroke is largely preventable, rendering measures of primary prevention valuable. Once the stroke has occurred, the likelihood of recurrence is high; thus secondary prevention is equally important.

ETIOLOGIC CONSIDERATION

Cardiac conditions that are considered as potentially embolic sources may be classified as being a major, minor or uncertain risk (Table 1).

MODE OF ECHOCARDIOGRAPHY

Transthoracic echocardiography (TTE) is a noninvasive procedure that carries little or no risk to the patient. Trasnsesophageal echocardiography (TEE) involves the introduction of an ultrasound transducer into the esophagus under conscious sedation. Although TTE remains the cornerstone of noninvasive cardiac imaging, TEE has become well accepted as a superior method for the identification of potential cardiac sources of emboli[3] including left atrial thrombi, valvular vegetations, thoracic aortic plaque, patent foramen ovale, and spontaneous left atrial echocardiographic contrast. The superiority of TEE for the diagnosis of these "causes" is likely related to the use of higher-frequency imaging transducers with enhanced spatial resolution, close proximity of the heart and esophagus and lack of intervening air or bone.

CARDIAC MASSES

Left Ventricular Thrombi

Cerebral embolism has been reported in 10% of patients with echocardiographic evidence of left ventricular thrombi. The use of TTE with higher frequency transducers (e.g., 5.0 MHz) readily identifies or excludes left ventricular thrombi in most

Table 1 : Potential cardioembolic sources.[2]

Major risk sources	Embolic event rate, % per year	Minor or uncertain risk sources	Embolic event rate, % per year
Atrial fibrillation	1-12	Mitral valve prolapse	<0.02
Intracardiac thrombus	0-35	Mitral annular calcification	?
Atrial myxoma	Sinus rhythm : 8-14 Atrial fibrillation : 31 Prior embolism : 31 -65	Spontaneous echo contrast	?
Mechanical valve (anticoagulated)	Aortic : 1.5 Mitral : 3	Left ventricular aneurysm	<1
Recent myocardial infarction	1-2	Atrial septal aneurysm	?
Infective endocarditis	12-40	Calcific aortic stenosis	?
Marantic endocarditis	14-90	Patent foramen ovale	?2
Dilated cardiomyopathy	4		
Aortic arch atheromatous plaques	4-16		

patients. Among patients with poor apical windows, or those in whom TTE data are equivocal, TEE is certainly a reasonable alternative for identifying these thrombi.[4]

Left Atrial Thrombi

Embolisation of left atrial thrombi account for >45% of cardiogenic thromboemboli. Left atrial thrombi are most often associated with atrial fibrillation or

rheumatic mitral stenosis. The sensitivity of TTE for the detection of left atrial thrombi is only 39-63%.[5] In contrast, TEE offers detailed visualization of both the body of the left atrium and the left atrial appendage. Careful discrimination of thrombi from left atrial pectinate muscles, as well as familiarity with the multilobed appearance of the normal left atrial appendage, can be better appreciated with a multiplane TEE. Among patients presenting with new-onset (>2 days) atrial fibrillation, TEE studies demonstrate left atrial thrombi in 12-15% of patients. The incidence approaches 50% in the setting of acute clinical thromboembolism.[6] It is seen in 27% of patients with chronic atrial fibrillation.

Systemic emboli are also commonly reported among patients with a dilated cardiomyopathy. Though historically, left ventricular thrombi had been presumed to be the source of emboli in these patients, left atrial thrombi are 4 times as frequent as left ventricular thrombi.[7]

Intracardiac Tumors

Myxomas constitute >50% of these lesions and the common clinical presentation of a myxoma is thromboembolism, either due to embolization of the tumor or overlying thrombus. Myxomas are typically found within the left atrium, classically attached to the interatrial septum in the area of the foramen ovale. Both TTE and TEE are highly sensitive in detecting myxomas. Although TEE is likely to be superior for detecting very small myxoma especially among patients with multiple myxomas, as in familial myxoma syndrome, TTE is generally adequate.

Pooled data from more than 30-cross sectional studies showed that the yield of echocardiography for the detection of intracardiac masses ranges from 0-21% with an

overall yield of 4 % for TTE and 11% for TEE.[2] Similar analysis also revealed that TTE can detect intracardiac masses in 13% and 0.7 % of patients with and without cardiac disease respectively. The corresponding values for TEE are 19% and 1.6%. The incremental yield of TEE in patients with negative results of TTE for the detection of intra cardiac masses (predominantly LA thrombi) approaches nearly 20% among patients with cardiac disease.[9]

THORACIC AORTIC ATHEROSCLEROSIS

Atherosclerotic plaques in the ascending aorta and aortic arch, have been reported in >60% of patients without any identifiable "other" cause of cerebral infarction. TEE is a very sensitive method for visualization of the aortic intima and has provided insights into the importance of aortic atherosclerotic material as source of systemic emboli.[10] Complex plaque (4 mm protrusion into the aortic lumen;) has been found in 28% of those without other known causes of thromboembolism, as compared with only 8% of patients with other known causes. The incidence of embolism is also higher when the plaque is mobile.[11]

PROSTHETIC VALVE THROMBI

Evaluation of mechanical and bioprosthetic valves for valvular function and exclusion of thrombi or vegetations is best performed by TEE. In this group, thrombus formation and subsequent embolisation may occur, especially in the setting of suboptimal anticoagulation. Patients with mechanical prostheses who present with evidence of systemic embolisation are generally assumed to have prosthetic valve thrombi (or vegetations), especially when the international normalized ratio (INR) is low.

INFECTIVE ENDOCARDITIS

The enhanced spatial resolution of TEE allows superior assessment of both native and prosthetic valves for vegetations. A prospective study of 96 patients with suspected endocarditis demonstrated a TEE sensitivity of 100% for vegetations compared with 63% by TTE. In a comparative study, analysis of 66 cases of suspected endocarditis, TEE had a sensitivity of 94% compared with 44% for TTE. Both had high specificity approaching 100%.[12]

Although the sensitivity of TEE for vegetations is quite high, data on the specificity of TEE for vegetations among patients with suspected cardiac source of emboli are unknown. Valvular "strands" i.e., mobile, filamentous echo densities have been frequently described on both aortic and mitral leaflets among elderly people and in patients following mitral valve replacement They probably represent benign fibrin strands. Their clinical relevance[13] and the impact of their identification on patient management are currently controversial.

ATRIAL SEPTAL DEFECTS

An ostium secundum atrial septal defect is the most common, accounting for approximately 70% of all atrial septal defects. TTE with good acoustic window is usually adequate for identification of ostium primum and most secundum type atrial septal defects. TEE has been shown to be superior for identification of smaller secundum-type defects and for visualizing the much less common sinus venous defects. TEE with color Doppler examination is usually sufficient, and saline contrast is generally not needed for atrial septal defects. The impact of anatomic size and location on the thromboembolic risk is not well defined.

Patent Foramen Ovale

Although the predominant flow of blood across an atrial septal communication is from the left to the right atrium. There is a transient reversal of flow when the right atrial pressure exceeds left atrial pressure. Such a situation may occur on a daily basis related to coughing or with Valsalva's maneuver. A thrombus in the venous system may thus cross to the left side of the heart, resulting in a systemic thromboembolism.

Diagnosis of a patent foramen ovale is typically made during antecubital vein infusion of agitated saline contrast injection following Valsalva release or with cough. Using TEE as the

"gold standard," several prospective studies have demonstrated that TEE with saline contrast is superior to TTE with contrast for the diagnosis of patent foramen ovale.[14] A landmark study by Lechat and coworkers[15] emphasized the common finding of transthoracic evidence of patent foramen ovale in younger adult patients with stroke. Among patients with ischemic arterial events considered to be due to paradoxical thromboembolism through a patent foramen ovale, right-to-left contrast shunting has been reported to be more severe, and the opening of the patent foramen ovale to be large.[16]

Atrial Septal Aneurysms

It is found in up to 8% of patients referred for TEE for various indications. Aneurysms of the interatrial septum involve the region of the fossa ovalis and are frequently associated with atrial septal defects or a patent foramen ovale.[17] Commonly, the aneurysm will protrude into the left atrium during early ventricular systole and rapidly swing into the right atrium or mid-position in late ventricular systole and diastole. TEE has been shown to be superior to TTE for the identification of these aneurysms. An atrial septal aneurysm in isolation does not predispose to TLA or a stroke but in the presence of a PFO, it potentiates the occurrence of a cerebrovascular event.[18]

SUMMARY

There is a fair evidence to recommend echocardiography in all patients with stroke and clinical evidence of cardiac disease or who are less than 45 years of age. TEE is the preferable modality found to be more cost effective and results in improved patient outcomes than TTE in a decision analysis of cardiac imaging studies after stroke. Newer risk factors, especially in young stroke like PFO, septal aneurysm detection helps in further definitive management, such as transcatheter closure.

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