Transesophageal Echocardiography

a report by
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Cardiovascular ultrasound is an established imaging modality in the practice of cardiovascular disease (CVD), whether this is provided by a CV specialist or health professionals with training in internal medicine. Transthoracic imaging wherein the transducer is placed on the chest wall has some limitations. These include inadequate quality of images resulting in poor information—approximately 5% of all patients undergoing transthoracic echocardiography may be the subject of poor quality images. Inability to view structures such as the arch of the aorta, descending thoracic aorta, and left atrial image, due to the location of these structures within the thorax, has led to innovations such as transesophageal ecocardiogram (ECG) (TEE) and intracardiac ECG.

Over the last three decades, TEE has evolved as an essential ultrasonographic technique for a rapid tomographic evaluation of the CV system. Imaging from the confines of the gastroesophageal track reduces signal attenuation and permits use of higher ultrasound frequencies, thereby providing superb spatial resolution. Although interpretation of the structural and hemodynamic information from TEE needs additional training, the technique has been integrated in the standard practice of CV ultrasound (CV), particularly those that demand quick medical decision-making. The role of TEE has become established beyond the confines of the CV ultrasound imaging and hemodynamic laboratory, and is being used with increasing frequency in the operating room (OR), with percutaneous procedures such as closure of defects within the heart, percutaneous implantation of valves, and surgical procedures being performed in the catheterization or the electrophysiologic laboratory. An increasing number of anesthetists, surgeons. and intensivists now use it routinely for monitoring and guiding operative procedures, interventions, and managing critically ill patients. This article briefly reviews the indications and emerging trends in the application of TEE.

TEE for recording continuous wave Doppler velocities of cardiac flow was first described by Side and Josling in 1971.[1] Subsequently, the first transesophageal M-mode ECG was reported by Frazin et al. in 1976,[2] while in 1977, Hisanaga et al. illustrated the use of cross-sectional realtime imaging using a scanning device that consisted of a rotating single element in an oil-filled balloon mounted at the tip of the gastroscope.[3] The initial acceptance of TEE was offset by the logistic difficulties of introducing rigid endoscopes. The ensuing technological developments that facilitated the transition of TEE to its present clinical status included the introduction of flexible endoscope, miniaturization and improvements in transducer designs, serial improvement in scanning capabilities from monoplane, biplane to multiplane views, and the addition of spectral and color Doppler imaging. TEE is currently used either as complementary or stand-alone treatment to a routine transthoracic ECG in approximately 5% to 10% of patients being referred for CV ultrasound imaging test.

Instrumentation, Procedure, and Complications

TEE can be performed as an out-patient or in-patient procedure. Fasting, as recommended for conscious sedation, appropriate intravenous (IV) access, careful history-taking to rule out the presence of laryngeal or gastroesophageal diseases, and removal of dentures are prerequisites. Absolute contraindications to TEE include esophageal stricture, diverticulum, tumor, and recent esophageal or gastric surgery. Topical spray, IV sedation, a drying agent to minimize oral secretion, and use of appropriate lubrication are helpful. Once in the esophagus, the transducer should be gently guided—the operator should never force this if they encounter resistance. Although the risk of bacterial endocarditis is extremely low and routine antibiotic prophylaxis before TEE is not advocated, it may be considered in high-risk patients such as those with a past history of infective endocarditis.

Although the study needs to examine all the regions of the heart and great vessels, examination can be initially targeted for resolving the primary indication for which TEE is being performed.

Each operator should establish a standard approach to obtaining all of the views when performing this examination.[4] The current best practice requires the use

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of a multiplane TEE transducer. The procedure should only be performed by adequately trained individuals.[5] Procedural risks, though low in trained hands, include transient throat pain, laryngospasm, aspiration, hypotension, hypertension, tachycardia, mucosal bleeding, esophageal rupture, and a rare risk of death. Benzocaine topical spray can cause toxic methemoglobinemia.

Clinical Applications

TEE has the unique advantage of portability and the ability to obtain high-resolution images of the normal and abnormal CV structures. Any condition where an echocardiographic evaluation is clinically indicated and in whom the transthoracic approach does not yield diagnostic quality images is therefore a potential indication for TEE. Some unique applications of TEE follow.

Infective Endocarditis

Despite technological advancements and the use of harmonic imaging, TEE continues to be superior to transthoracic ECG for more effective delineation of the shape and size of vegetations. Left-sided vegetations pose an increased risk of systemic embolism. The risk of embolism has been shown to increase with increasing size of vegetation.[6] TEE is also important for assessing the structural complications such as myocardial abscess, fistulas, mycotic aneurysms, valvular aneurysms or perforations, flail leaflets, or prosthetic valve dehiscence. TEE has a higher sensitivity (76% to 100%) and specificity (94%) than transthoracic ECG for diagnosing perivalvular extension of infection.[7] The cost-effectiveness and incremental utility of TEE when used in conjunction with the clinical information is particularly high in patients who have an intermediate clinical likelihood of infective endocarditis.[8] A negative TEE in a patient with suspected infective endocarditis virtually rules out an infection of the native valve, except in a very early phase of the disease when vegetations may not be detected. When clinical suspicion of infective endocarditis is high and results from TEE are negative, a repeat TEE is warranted within seven to 10 days, which may demonstrate previously undetected vegetations or abscess.

Evaluation of the Patient with Prosthetic Valves

TEE is the procedure of choice for detecting abnormalities of mitral valve prostheses and prosthetic valve dysfunction related to perivalvular regurgitations, cusp abnormalities in tissue prosthesis, embolic events, patient-prosthesis mismatch, and malfunction of repaired valves and implanted rings.[9]

Embolic Events

TEE has been shown to have a higher accuracy in identifying abnormal lesions such as thrombus in atria, atrial appendage, plaques in the aorta, and patent foramen ovale in patients with cardio-embolic strokes.[10] The diagnostic yield of TEE for a cardiac source of emboli in a group of patients presenting with unexplained stroke or transient ischemic attacks is high with potential lesions identified in over 50% of the studies. However, one-third of patients who have a cardio-embolic stroke also have concomitant cerebral or vascular atherosclerosis, and this can confound the diagnosis in a given case. Moreover, no absolute clinical or laboratory gold standard exists for diagnosing a potentially cardio-embolic lesion; hence, risk stratification schemes have been suggested based on strength of the association of a given lesion with ischemic strokes.

Atrial Fibrillation

Atrial arrhythmias predispose to emboli formation. A sustained impairment or transient stunning results in poor emptying and enlargement of left atrium and left atrial appendage, leading consequently to stasis and thrombus formation.[11] An annual thromboembolic event rate of 12% has been observed in patients with spontaneous echocardiography contrast compared with 3% in patients without it.[12]

Echocardiographic risk factors include left ventricular (LV) systolic dysfunction, LV hypertrophy, left atrial enlargement and spontaneous echocardiographic contrast. The absolute risk of stroke in atrial fibrillation shows marked variation with age and co-existing CVDs, ranging from 2% to 18% per year depending on the investigated patient population.[13] Short-term anticoagulation, combined with TEE before cardioversion, has been suggested to be an effective alternative to three to four weeks of empiric anticoagulation before cardioversion.[14]

Economic analysis of TEE-facilitated acute cardioversion has been shown to result in a higher initial treatment costs but a lower subsequent outcome-associated costs, resulting in no significant cost difference between the two strategies.[15]

Aortic Diseases

Transesophageal examination is a valuable clinical modality for managing patients with aortic diseases. It is particularly advantageous in patients with aortic dissections, intramural injury, and aortic trauma.[16] In a comparative imaging of multiplane TEE with spiral computed tomography (CT) and magnetic resonance imaging (MRI), the sensitivity and specificity of TEE for

diagnosing aortic dissections has been reported as 98% and 95%, respectively;[17] however, care needs to be taken to differentiate reverberation artifacts. TEE has also been found useful in screening patients with suspected aortic trauma and for diagnosing aortic intramural hematomas.

Studies have shown an association between large atheromas in the ascending aorta and the aortic arch, and an increased risk of cerebral embolic events in patients older than 60. In a recent study, the association between previous ischemic strokes, transient ischemic episodes, and aortic atherosclerosis was found to be insignificant once age- and gender-related adjustments were made.[18] The overall importance of aortic atherosclerosis in the pathogenesis of cerebrovascular accidents is not clear and needs to be correlated with associated risk factors such as age, hypertension, elevated body mass index (BMI), and smoking.

Cardiac Masses

TEE is particularly advantageous in detecting masses posterior to mechanical device or in the left atrial appendage. TEE is also useful in the detection of thrombi lying in the proximal portion of the pulmonary arteries.[19]

Congenital Heart Diseases and Intracardiac Shunts

TEE is superior to surface ECG for the evaluation of specific defects, such as atrial septal defects, anomalous pulmonary venous connections, and complex cardiac malformations. TEE is recommended in any patient with an unexplained dilatation of the right side of the heart for excluding sinus venosus atrial septal defect and anamolous pulmonary veins.[20] TEE is also useful for defining the margins of an atrial septal defect for defining candidates who may benefit from non-surgical device closure of the defect.

TEE is particularly advantageous in imaging the interatrial septum because the esophageal probe faces the septum nearly perpendicularly. The image quality is superior to transthoracic ECG and echo-dropouts are virtually non-existent. TEE has been used for detecting patency of the foramen ovale in adults. Valsalva maneuver enhances the value of the microbubble test. Patent foramen may also be associated with atrial septal aneurysms and presence of both these lesions have also been implicated in recurrent embolic strokes.[21]

Critically Ill Patients

The limited acoustic windows in critically ill patients make TEE an attractive alternative to transthoracic ECG. In addition to the usual indications for TEE (suspected endocarditis, source of embolus, and suspected aortic dissection), there are several indications that are unique to critical care patients. These include assessment of unexplained hypotension, suspected massive pulmonary embolism, unexplained hypoxemia, and complications of cardiothoracic surgery. Unlike transthoracic ECG, TEE can visualize emboli lodged in the proximal pulmonary arteries. The right pulmonary artery can be observed for most of its course; however, the left pulmonary artery can rarely be observed beyond the first two centimeters. Less common indications for TEE in the critical care unit include continuous hemodynamic monitoring, evaluation of potential transplant donors, and guidance of central-line placement. The recent development of transnasal TEE probes may allow for monitoring in the awake patient.

TEE as a Procedural Adjuvant

Intraoperative ECG has also been found to be cost-effective in children undergoing cardiac surgery for congenital heart lesions.[22]

TEE is also an important adjuvant in the interventional laboratory for treating congenital cardiac lesions. It plays an important role in transcatheter closure of atrial septal defects and ventricular septal defects. It is used before the procedure for identifying the defect, excluding multiple defects, measuring the adequacy of the rim of the inter-atrial septum and its distance from the pulmonary vein and the mitral valve and superior vena cava, balloon sizing of the stretched diameter, and for proper placement of the occluder. TEE is also an important imaging modality for blade atrial septostomy and closure of baffle fenestrations following total caval pulmonary connection and closure of baffle leak following Mustard or Senning surgeries.

In adults undergoing cardiac interventions, TEE is particularly useful during transcatheter closure of patent formen ovale (PFO) in patients who have embolic strokes. Other interventional procedures where TEE is useful include balloon mitral valvuloplasty, non-surgical reduction of ventricular septum in patients with hypertrophic cardiomyopathy, and trans-septal catheterization for the placement of catheter during radiofrequency ablation of cardiac arrhythmias.

TEE also plays an important role in patients with heart failure undergoing implantation of LV assist devices for selecting the type of the assist device necessary (right versus left, or biventricular), optimization of device performance, the evaluation of hypoxemia, and the determination of patients ability to be weaned from the mechanical device.[23] A correct positioning of a canula under TEE guidance optimizes the LV filling, besides intraoperative recognition of RV failure, which can decrease pump flow due to inadequate left-sided filling.

Future Directions

Easy applicability, lower costs, portability, and the instantaneous availability of test results have made TEE a critical imaging modality. Miniaturization of the TEE transducer design is in the works. The intracardiac transducers to some degree base their pedigree on TEE transducer miniaturization. Realtime three-dimensional (3-D) imaging using TEE is in evolution, and will be available in the near future. ■

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