

Perioperative transesophageal echocardiography: State of the art 2016

INTRODUCTION

Transesophageal echocardiography (TEE) as an imaging modality is instrumental in providing guidance in numerous cardiovascular (CV) surgical and percutaneous procedures. The capability to use TEE peri (pre, intra, and post)-operatively has become the cornerstone to successful outcomes after CV procedures.

For many decades, routine use of perioperative TEE has been an integral component of cardiothoracic surgery operating rooms (ORs).^[1] However, with the recent advances in percutaneous transcatheter therapies, perioperative TEE has seen an unprecedented growth in its use in modern day cardiac catheterization laboratories and hybrid ORs.

The flexibility and ease with which we can routinely use two-dimensional (2D) and three-dimensional (3D) perioperative TEE has revolutionized procedural care in cardiology. In this editorial, we aim to discuss emerging indications of perioperative TEE with an objective to lay out the landscape of the multidisciplinary heart team approach, which is a core element in the American Heart Association/American College of Cardiology guidelines.^[2]

USE OF PERIOPERATIVE TRANSESOPHAGEAL ECHOCARDIOGRAPHY IN EMERGENCIES

Transthoracic echocardiography is usually adequate in rapid screening and diagnosis of the majority of CV emergencies encountered in routine clinical practice. However, TEE plays a critical role in diagnosis and management of acute aortic dissection including establishing the extent to assess the involvement of the coronary sinuses and the aortic root as well as the coronary arteries. One could assess

the life-threatening situation readily with perioperative TEE thereby negating the need for the use of radio-opaque contrast and enabling for surgery to be planned promptly. In addition, biventricular and valvular function can be assessed rapidly with the use of perioperative TEE in such scenarios.

USE OF PERIOPERATIVE TRANSESOPHAGEAL ECHOCARDIOGRAPHY IN PROCEDURES

Surgical and hybrid operating rooms

Perioperative TEE is performed routinely in CV surgery ORs in valvular heart diseases and thoracic aortic surgical procedures.^[3] However, for valvular heart disease cases, the severity of regurgitant lesions is partly dependent on loading conditions. Therefore, the conventional thinking and recommendations by the current guidelines are that one should not evaluate the severity of valvular regurgitation under anesthesia in OR.^[3]

Other uses of perioperative TEE are in cases of coronary artery bypass grafting for assessment of biventricular function and in select cases of noncardiac surgery.^[3] In addition, perioperative TEE is frequently employed for prompt recognition of retained air and thorough examination of de-airing techniques.^[4] The rare but commonly lethal iatrogenic development of bronchopulmonary vein fistula can also be detected during perioperative TEE.^[5]

Mitral valve surgeries

Mitral valve (MV) anatomy can be assessed in OR at the time of surgery to assess its suitability for repair versus replacement. In patients with functional mitral regurgitation (MR) undergoing undersized annuloplasty, recurrent MR is seen in ~70% of patients at 5 years.^[5] There are various risk factors identified for recurrence which mainly include more severe

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preoperative MR, multiple or centrally directed jet, severe LV dilation, anterior leaflet tethering, ≥ 11 mm coaptation height, basal segment dyskinesia, and a posterior leaflet angle of $>45^\circ$. During the MV surgery for MR or mitral stenosis, perioperative TEE is a useful aid to monitor the hemodynamic status, biventricular function, associated tricuspid regurgitation, new regional wall motion abnormality, paravalvular leak (PVL) and to establish the severity of residual MR after MV surgery.

Aortic valve surgeries

Surgical aortic valve replacement has been the gold standard for treatment of aortic valve disease. However, since last decade, we have seen increasing use of transcatheter aortic valve replacement (TAVR) in elderly patients with severe aortic stenosis who are at high risk for surgery.^[6] Several studies have shown that the left ventricular outflow tract is an elliptical structure and not circular as has been traditionally believed. Multimodality imaging including the use of perioperative 3D TEE helps in accurately determining the size of the aortic valve to be implanted. During TAVR, perioperative TEE helps in the positioning of the catheter, evaluates the distance to the coronary artery orifices, serves as a guide during inflation of the balloon and expansion of the valve and aids in the assessment of postprocedure PVLs, all of which are important considerations for a successful outcome.^[7] In addition, several complications during TAVR procedure such as thrombus formation or tamponade can be rapidly screened with the use of perioperative TEE.

Left ventricular assist device

In end-stage heart failure patients, we have seen an increase in the use of left ventricular assist device (LVAD) placement. During LVAD placement, perioperative TEE is useful to assess right ventricular systolic function, presence of any intracardiac shunts, valvular heart disease, and device position and function.^[8] TEE is also helpful to detect air in the heart after placement of LVAD.^[9]

Cardiac catheterization laboratories

MitraClip

Percutaneous therapies for MV like MitraClip is an addition to contemporary management of severe MR. Perioperative TEE is an essential tool to determine the overall feasibility of the procedure. Although initial trials using the MitraClip device were conducted in patients with degenerative MR, there has been some success in the treatment of functional MR cases as well.

In assessing patients for MitraClip procedure, following perioperative TEE parameters are associated with successful outcomes: (1) MVA ≥ 4 cm², (2) central A2P2 pathology, (3) in patients with functional MR, coaptation depth ≤ 10 mm and coaptation length ≥ 2 mm; in patients with degenerative MR flail gap < 10 mm and flail width < 15 mm and posterior leaflet > 10 mm.^[10]

Perioperative 3D TEE guidance is essential during the procedure in the following ways: (1) helps to guide the trans-septal puncture, (2) aids in steering and positioning of MitraClip delivery system, and (3) allows the grasping of the leaflets and assessment of leaflet insertion in the MitraClip. In addition, postprocedure assessment of residual MR and any complications such as significant atrial septal defects (ASDs) or cardiac tamponade can be quickly recognized. Figure 1 shows 3D perioperative TEE image of a patient who underwent MitraClip implantation at our institution.

Vascular plug for paravalvular leaks

PVLs associated with surgical prosthetic valve implantation are associated with severe morbidity in 1%–5% of patients.^[11] With the maturity of percutaneous techniques, vascular plugs have been increasingly used to treat PVLs with successful outcomes. Perioperative 3D TEE is useful in directing the catheter to the site of leak and implantation of vascular plugs as shown in an example case in Figures 2 and 3.

Left atrial appendage occlusion device

Advances in perioperative TEE have revealed the complexities of the left atrial appendage (LAA)



Figure 1: Peri-operative three-dimensional transesophageal echocardiography in a patient who underwent MitraClip procedure for severe mitral regurgitation at our institution. Two MitraClips were inserted at A2P2 segment/scallop with a tissue bridge in the center

anatomy and function, which was once considered a redundant structure. Occlusion of LAA with LAA occlusion (Watchman) device recently gained approval by the Food and Drug Administration in patients who are not candidates for long-term oral anticoagulation therapy.^[12] In such cases, perioperative 2D and 3D TEE are used to measure LAA ostium and length in multiple planes to accurately determine the optimal size of the device for closure. During the procedure, perioperative TEE also aids in accurate placement [as shown in a case from our echocardiography laboratory in Figure 4] and assessment of any residual flow from left atrium to the LAA.

Septal occluder device

Atrial septal occluder devices for secundum ASD have been used in clinical practice since 1970's.^[13,14] However,

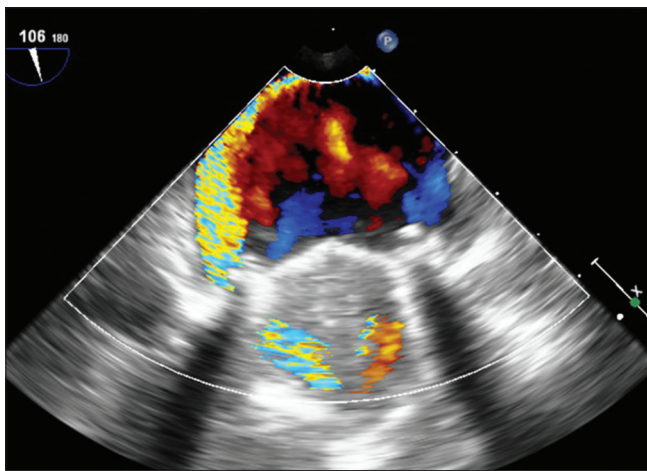


Figure 2: Perioperative transesophageal echocardiography in a patient with paravalvular leak after bileaflet prosthetic mitral valve implantation. Severe medial mitral regurgitation jet



Figure 4: Perioperative three-dimensional transesophageal echocardiography guiding placement of Watchman device in a patient who presented for the left atrial appendage occlusion

accurate sizing of the defect has been achievable with the advent of 3D perioperative TEE. Often times, 3D visualization of atrial septum allows studying the morphological features of secundum ASD and determines successful transcatheter closure (as shown in Figure 5 from a patient who presented for closure of secundum ASD at our institution). Rim Deficiency (<5mm in size and >25% in extent) is frequently associated with increased risk of erosions into aorta or roof of the atrium. Complicated anatomy like multiple defects can also be detected with the use of perioperative TEE that can serve as a valuable guide in the decision-making of choosing the optimal approach, i.e., percutaneous versus surgical for closure of the defect.

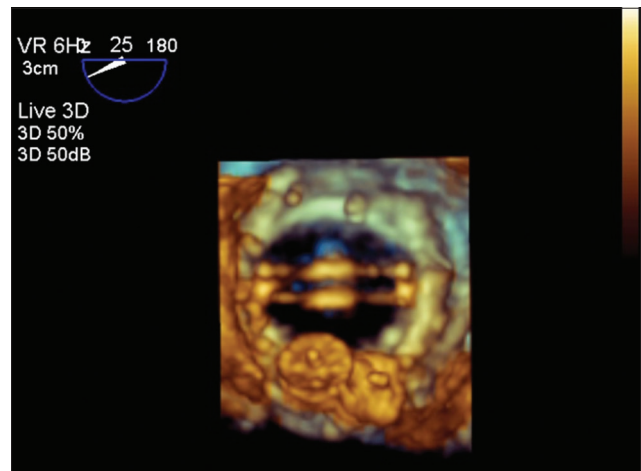


Figure 3: Perioperative transesophageal echocardiography in a patient with paravalvular leak after bileaflet prosthetic mitral valve implantation. Placement of two vascular plugs to successfully occlude the defect

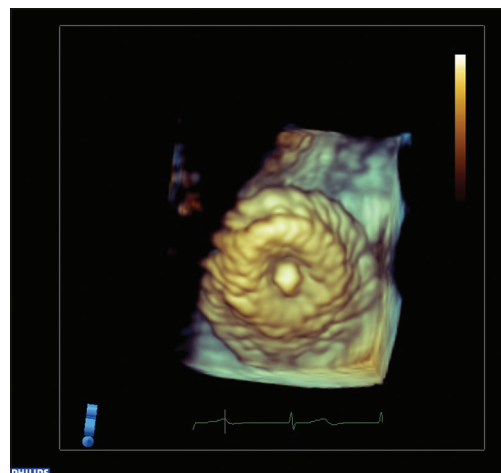


Figure 5: A perioperative three-dimensional transesophageal echocardiography image from a patient who underwent secundum atrial septal defect closure using an atrial septal occluder

CONCLUSION

Use of perioperative 2D and 3D TEE in CV surgeries and percutaneous interventions has established a milieu of a multidisciplinary heart team approach. As new percutaneous therapies continue to advance, routine availability of perioperative TEE has become central in determining the success and outcomes of these procedures. Skills and expertise above and beyond knobology required for perioperative TEE should continually be developed among physicians to achieve adequate competency in performing these highly complex examinations.



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