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The Standard TEE Examination: Procedure, Safety, Typical Cross-Sections and Anatomic Correlations, and Systematic Analysis

Frank A. Flachskampf, MD

Multiplane transesophageal echocardiography (TEE) is a semi-invasive, very low-risk imaging procedure utilizing the upper gastric and esophageal echo windows to image the heart with the use of high-frequency transducers. It allows for high spatial resolution and access to structures that are routinely not well seen by transthoracic echocardiography, such as the left atrial appendage, the thoracic aorta, and the pulmonary veins, or where transthoracic imaging may be insufficient to answer a specific question, such as the presence of small vegetations, endocarditic abscesses, abnormalities of the interatrial septum, and others. Another important indication is the ventilated patient or the patient in the operating room, where transthoracic echocardiography is unrewarding or impossible. A particular role has emerged for TEE for identifying candidates for mitral valve repair by providing detailed functional and morphologic information on the diseased valve and by checking intraoperatively the results of surgery. A set of cross-sections, defined by anatomic landmarks, has been compiled, which can be systematically sought, evaluated, and modified according to the clinical question in order to extract the maximal information from TEE.

The transesophageal echocardiographic (TEE) examination is a semi-invasive diagnostic procedure indicated when transthoracic echocardiography is unable or, in some cases, unlikely to answer the clinical question.¹⁻³ Among the typical indications for TEE in a cardiology practice are the search for a cardiac source of embolism, left atrial appendage thrombi, infective endocarditis, mechanism and location of mitral regurgitant lesions, prosthetic malfunction or thrombosis, and aortic dissection.

In the intraoperative environment, where transthoracic echocardiography is unfeasible, indications for TEE include intraoperative monitoring of left ventricular function in cardiac and non-cardiac surgery, and in particular, assessment of results after mitral and aortic valve repair.

TEE is performed via a miniaturized transducer mounted on an endoscopic shaft. Today's TEE transducers are multiplane (ie, rotatable within their casing by 180°). They usually work at 5 to 7 MHz, and provide all typical echocardiographic modalities, including Doppler. The instrument tip that houses the transducer can be flexed laterally or anteroposteriorly, and the whole probe can be rotated.

After consent is obtained and the patient has fasted for at least 4 to 6 hours, oropharyngeal topical anesthesia is applied. Mild sedation, such as with intravenous midazolam (2 to 4 mg), may be beneficial, but use varies widely from never to always.

The probe is then introduced by asking the conscious patient to swallow. During probe introduction and TEE examination, electrocardiographic monitoring is mandatory, and oxygen saturation monitoring may be useful. The sequence of the examination is not standardized (Table 1). If the procedure is badly tolerated, the main structure of interest should be visualized immediately, lest the procedure has to be aborted without answering the clinical question (Table 2). In our laboratory, if the procedure is well tolerated, we start with transgastric views (Figure 1), followed by pulling the probe up to esophageal views (Figures 2 and 3) and finishing with imaging the descending aorta and aortic arch (Figure 4).

Typical Cross-sections

The views described in Table 1 and shown in Figures 4 to 12 need to be adapted and extended according to the individual patient and the pathology.

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Table 1. Typical Views for Typical Indications*Transgastric views:*

1. Short axis view of the left ventricle at the papillary muscle level and at the mitral valve level (0°) (Figure 5).
2. Two-chamber view of the left ventricle (90°) (Figure 6).
3. Right heart views (long-axis view of the right ventricular inflow and outflow tract, at 0°–90°).
4. Deep transgastric view with maximal antelexion of tip, yielding a four-chamber or long axis view (0°–90°).

Lower transesophageal views of the left ventricle:

1. Four-chamber or five-chamber view (0°) (Figure 6).
2. Two-chamber view (60°–90°) (Figure 7).
3. Long-axis view (120°) (Figure 8).
4. Multiple mitral valve cross-sections (0°–180°).

Upper transesophageal views:

1. Aortic valve long (120°–150°) and short-axis views (30°–60°) (Figure 4, Figure 9).
2. Left atrial appendage and left upper pulmonary vein views (0°–90°) (Figure 4, Figure 10).
3. Main pulmonary artery and cranial atrial view (0°).
4. Sagittal view of the right and left atrium and superior caval vein (90°) (Figure 11, Figure 12).
5. Right upper pulmonary vein (0–90°).

Aortic views (cross-sectional at 0° and longitudinal at 90°):

1. Descending aorta.
2. Aortic arch.
3. Ascending aorta.

Safety

Complications in TEE are rare, but may occur. A few deaths, resulting from such events as esophageal rupture or esophageal tumor hemorrhage, have been reported. It is mandatory to ask the patient about swallowing problems and, in particular, a history of esophageal disease such as strictures, diverticula, or tumors. Any true resistance to introduction should be respected and the procedure aborted.

Anticoagulation or thrombocytopenia entail an enhanced bleeding risk but are not absolute contraindications. Bradycardia or tachycardia may occur, especially during probe introduction. Sedation may lead to hypoxia and apnea. Rarely, methemoglobinemia due to the topical anesthetic agents prilocaine and benzocaine, in particular, has been observed.⁴

Endocarditis prophylaxis is not recommended for TEE; however, instrument cleaning and disinfection prescriptions must be observed carefully. Electrical current leakage may occur after damage to the probe, such as from the patient's teeth; therefore, the probe has to be inspected after each use.

Conclusions

A complete transesophageal echocardiographic examination, including multiple views, measurements of valve areas, and determination of ventricular function, is essential for optimal cardiac diagnosis.

Table 2. Essential Structures and Views in Specific Clinical Scenarios^a**1. Source of embolism**

- Left atrial appendage (including pulsed wave Doppler); note spontaneous contrast.
- Left atrial body; note spontaneous contrast.
- Left ventricular apex or aneurysm (transgastric and low transesophageal two-chamber views).
- Aortic and mitral valve.
- Ascending and descending aorta and aortic arch.
- Interatrial septum: foramen ovale, septal defect, septal aneurysm; contrast and Valsalva maneuver.

2. Infective endocarditis

- Mitral valve in multiple transesophageal cross-sections.
- Aortic valve in long- and short-axis view; para-aortic tissue (in particular, short-axis views of aortic valve and aortic root) to rule out abscess. Tricuspid valve in transgastric views, low esophageal view, and right ventricular inflow-outflow view.
- Tricuspid valve in transgastric view at 90°, transesophageal four-chamber view, upper transesophageal short-axis view of aortic valve at 30° to 60°
- Pacemaker, central intravenous lines, Eustachian valve in longitudinal right atrial views at 90°.

3. Aortic dissection, aortic aneurysm

- Ascending aorta in long-axis and short-axis views, maximal diameter; note flap or intramural haematoma, para-aortic fluid.
- Descending aorta in long- and short-axis views; note maximal diameter, flap, intramural haematoma, para-aortic fluid.
- Aortic arch; note maximal diameter, flap, intramural haematoma, para-aortic fluid.
- Entry and re-entry sites of dissection.
- Spontaneous contrast or thrombus formation in false lumen (color Doppler to characterize flow or absence of flow in false lumen).
- Aortic valve (regurgitation, annular diameter, number of cusps). Relation of dissection membrane to coronary ostia.
- Pericardial effusion, pleural effusion.

4. Mitral regurgitation

- Mitral anatomy (transgastric basal short-axis view, multiple lower transesophageal views).
- Mechanism and origin of regurgitation (detection and mapping of prolapse/flail to leaflets and scallops, papillary muscle and chordal integrity, vegetations, paraprosthetic leaks).
- Left atrial color Doppler mapping with emphasis on jet width and proximal convergence zone.
- Left upper pulmonary venous flow; if severe mitral regurgitation is suspected and no reverse systolic flow detected, record also right upper pulmonary venous flow.

5. Prosthetic valve evaluation

- Morphologic and Doppler evidence of obstruction (reduced opening/mobility of cusps/disks/leaflets and elevated velocities by CW)
- Morphologic and Doppler evidence of regurgitation, with mapping of the origin of regurgitation to specific sites (transprosthetic, paraprosthetic); presence of dehiscence.
- Presence of morphologic changes in the prosthetic structure: calcification, perforation of bioprostheses, absence of occluder.
- Presence of additional paraprosthetic structures (vegetation, thrombus, or pannus; suture material, strand, abscess, pseudoaneurysm, fistula).

6. Left ventricular function

- Transgastric short- and long- axis views.
- Transesophageal four-chamber, two-chamber, and long-axis views.

^aAdapted from reference 1.

Abbreviations for figure captions:

AL = anterolateral commissure or scallop of the posterior mitral leaflet; AL-PM = anterolateral papillary muscle; AML = anterior mitral leaflet; ANT = anterior wall of aortic arch; AOA = ascending aorta; AV = aortic valve; AW = anterior wall of left ventricle; CS = central scallop; IVC = inferior vena cava; IW = inferior wall of left ventricle; LA = left atrium; LAA = left atrial appendage; LUPV = left upper pulmonary vein; LV = left ventricle; LVOT = left ventricular outflow tract; PA = main pulmonary artery; PFO = patent foramen ovale; PM = posteromedial commissure or scallop of the posterior mitral leaflet; PML = posterior mitral leaflet; PM-PM = posteromedial papillary muscle; RA = right atrium.

Figure 1. Schematic drawing of a typical transgastric view (reproduced from reference 1, with permission).

Figure 2. Schematic drawing of a typical lower transesophageal view (reproduced from reference 1, with permission).

Figure 3. Schematic drawing of a typical lower transesophageal view (reproduced from reference 1, with permission).

Figure 4. Schematic drawings of a typical upper transesophageal views (reproduced from 1, with permission).

Figure 5. Normal transgastric short-axis view of the left ventricle at 0°.

Figure 6. Normal transesophageal four-chamber view at 0°.

Figure 7. Normal transesophageal two-chamber view at 90°.

Figure 8. Transesophageal long axis view at 130° with focal aortic valve sclerosis.

Figure 9. Transesophageal (A) long- and (B) short-axis views of a normal aortic valve.

Figure 10. Upper transesophageal view of left atrial structures in an intermediate view at 58°.

Figure 11. Sagittal view of normal right atrium and caval veins at 90°.

Figure 12. Close-up of patent foramen ovale at 0°.

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