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Transesophageal echocardiography

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Abstract

Transthoracic and transesophageal examinations should be considered as mutually complementary. Transesophageal echocardiography is performed in cases of a justified need to visualize structures that are poorly visible or invisible on transthoracic echocardiogram. Primary indications for transesophageal echocardiography include an assessment of cardiac source of embolism, suspected endocarditis, suspected prosthetic valve dysfunction, an assessment of thoracic aorta and other vessels, an assessment prior to valvular repairs and closures of septal defects, intraoperative monitoring of cardiac or percutaneous interventions, ablation, non-diagnostic transthoracic examination, especially in patients after cardiac surgeries. Serious complications after transesophageal examination are very rare. This type of examination should not be performed in patients who consumed a meal 4–6 hours before the test, or when there is a risk of esophageal perforation and massive gastrointestinal bleeding. The test should be performed in an appropriately accredited laboratory and by a cardiologist with an individual accreditation. Transesophageal echocardiography may be performed in an outpatient setting. It should be recorded using the available media. The description should include comprehensive answers to questions in the referral. Transesophageal examination requires patient consent. It is performed using a multiplanar probe, which ensures the best conditions for imaging of the heart and the thoracic aorta. First of all, the reason for referral should be diagnosed. Depending on the setting depth, the following views may be distinguished: low transesophageal view (the probe is advanced approximately 30 cm from the teeth), mid transesophageal view (the probe is advanced approximately 30 cm from the teeth), high transesophageal view (the probe is advanced approximately 25–30 cm from the teeth), transgastric subcardiac view (the probe is advanced approximately 35–40 cm from the teeth), transgastric five-chamber view (the probe is advanced deeper than in the subcardiac view and with a stronger anterior flexion of the probe, aortic (the probe should be rotated at about 180°).

Introduction

Transesophageal echocardiography (TEE) became a popular method when a miniature echocardiographic probe could be mounted on the tip of a gastroscope. In the early 80s of the last century, uniplanar transducers, which allowed for cardiac examination in the transverse plane, were used. Two-planar probes introduced in the decade that followed made it possible to perform heart imaging in transverse and longitudinal planes. In the second half of the 90s, multiplanar transducers with a smooth adjustment of the angle of the section plane from 0° to 180° were introduced. Contemporary multiplanar transducers allow for the imaging of the heart and the thoracic aorta in one- and two-dimensional views, using all Doppler techniques, including tissue Doppler. Clinical trials on transesophageal transducers for three-dimensional real-time imaging are underway.

Indications for transesophageal echocardiography

Transthoracic (TTE) and transesophageal examinations should be considered as mutually complementary. TEE should be performed in cases of justified need to visualize structures that are poorly visible or invisible on transthoracic echocardiogram[1–3]. Final decision to conduct the examination is made by the performing cardiologist.

Primary indications for transesophageal echocardiography include an assessment of cardiac source of embolism (Tab. 1); suspected endocarditis, especially in a patient with prosthetic valve (Tab. 2); suspected prosthetic valve dysfunction (Tab. 3), an assessment of the thoracic aorta (Tab. 4) and other vessels (pulmonary trunk and arteries, pulmonary veins, coronary arteries); an assessment of mitral regurgitation (Tab. 5); an assessment prior to valvular repairs and closures of septal defects; congenital heart defects; intraoperative monitoring of cardiac or percutaneous interventions, including ablation; non-diagnostic transthoracic examination, especially in patients after cardiac surgeries.

The risk associated with transesophageal echocardiography

Serious complications after TEE are very rare and include spasm, esophageal perforation, massive bleeding from esophageal tumor, and arrhythmia, including cardiac arrest. Deaths associated with TEE were reported in patients with acute aortic dissection, in whom aortic rupture was due to a sudden increase in blood pressure.

Patient preparation and laboratory equipment

Patient preparation involves providing information about the procedure; obtaining patient consent; collecting medical history (the last meal, esophageal conditions, allergy to lidocaine); removal of mobile dentures from the oral cavity and the use of pharyngeal anaesthesia with 10% lidocaine spray; ensuring venous access; placement of electrocardiogram (ECG) electrodes; placing the patient on his or her left side with the left hand under the head; placing a mouthpiece. Restless patients or patients with suspected

Tab. 1. *The use of transesophageal echocardiography for the assessment of cardiac source of embolism*

• Cardiac apex, aneurysm (transgastric views, mid transesophageal two-chamber view)
• Aortic and mitral valve (vegetations, degenerative lesions, tumors, e.g. fibroelastoma)
• Ascending and descending aorta, aortic arch
• Left atrial appendage (flow and spontaneous contrast-enhancement)
• Left atrium (spontaneous contrast-enhancement)
• Atrial septum (the foramen ovale, persistent foramen ovale, septal aneurysm; contrast-enhanced echo, Valsalva maneuver)

Tab. 2. *Primary indications for transesophageal echocardiography – infectious endocarditis*

• Mitral valve in multiple views
• Aortic valve in long- and short-axis-view, perivalvular tissue (short axis; search for abscesses)
• Tricuspid valve (transgastric views; low transesophageal view; right-ventricular inflow-outflow view – high transesophageal view)
• Electrodes, catheters, prosthetic vessels, Eustachian valve, the Chiari network, pulmonary valve

Tab. 3. *Primary indications for transesophageal echocardiography – suspected prosthetic valve dysfunction*

• Morphological and/or Doppler symptoms of prosthetic stenosis (reduced opening/mobility of cusps/discs and increased flow velocity)
• Morphological and Doppler symptoms of prosthetic regurgitation with the mapping of the regurgitation site (transvalvular, para-ring); prosthetic instability
• Morphological changes in the prosthesis: calcifications, immobilization, rupture or perforation of biological prosthesis cusps; absence of mechanical valve occluder
• The presence of additional structures (vegetations, thrombi, pannus, sutures, fibrin threads, abscesses, pseudoaneurysm, fistula)

Tab. 4. *Primary indications for transesophageal echocardiography – suspected aortic dissection, aortic aneurysm*

• Short-axis ascending aorta in different views (maximum width, dissected membrane, hematoma, periaortic fluid)
• Long- and short-axis descending aorta in different views (maximum width, dissected membrane, hematoma, periaortic fluid)
• Aortic arch (maximum width, dissected membrane, hematoma, periaortic fluid)
• Aortic regurgitation (mechanism, the size of aortic ring and aorta; the number of cusps)
• Location of the dissected membrane relative to coronary artery orifices
• Pericardial sac and pleural fluid
• The site of dissection inlet and outlet
• Spontaneous contrast-enhancement, clots in the pseudo-canal (differentiation between pseudo-canal and a real canal)

Tab. 5. *Primary indications for transesophageal echocardiography – mitral regurgitation*

• Mitral valve morphology (short-axis transgastric view, mid transesophageal views); regurgitation mechanism; location of regurgitation orifice; cusp/cusp segment prolapse; morphology/function of papillary muscles and heart strings; vegetations, paravalvular leak
• Color Doppler mapping of the regurgitation jet (width, inflow convergence area)
• Reverse flow in the left or right upper pulmonary vein (eccentric regurgitation jet)

aortic dissection should receive intravenous midazolam (0.05–0.1 mg/kg) or diazepam (0.1–0.2 mg/kg).

Patients are instructed to fast for 1.5–2 hours after the examination.

TEE should be performed in a laboratory with B or C accreditation, and featured with resuscitation equipment (defibrillator). The exam may be performed in an outpatient setting. It should be performed or supervised by a trained cardiologist with an individual accreditation, always in the presence of another person (a nurse or a trainee doctor). Prophylactic antibiotic therapy for endocarditis is not recommended. There is no need to use a protective cover when examining patients with HIV, viral hepatitis or infectious endocarditis.

It should be ensured that the probe is disinfected, the continuity of gastroscope cover is maintained, as well as that the mobility of the tip is preserved and that smooth angle adjustment is possible.

Once the examination is over, the probe should be thoroughly washed under cold running water and disinfected by immersing it in a disinfectant fluid for certain length of time in accordance with manufacturer's instructions. After disinfection, the probe should be washed under cold running water and thoroughly dried.

TEE should not be performed in patients who had a meal 4–6 before examination or when there is a risk of esophageal perforation and massive gastrointestinal bleeding.

Documentation

The examination should be recorded using the available media. TEE report should include comprehensive answers to questions in patient's referral. If the detected pathological lesions may be visualized only in a given view, a view different than standard views in particular, the position of the probe (depth, tip flexion, section plane angle) should be specified. The description should also include an assessment of the left atrium and its appendage, the atrial septum, heart valves and thoracic aorta. Furthermore, information on premedication used and difficulties encountered during the procedure should be included in the report.

Methodology of transesophageal echocardiography

TEE is performed using a multiplanar probe, which ensures the best conditions for imaging of the hart and the thoracic aorta. The control wheels should be unlocked during insertion; the patient swallows the probe, breathing through the nose. Under no circumstances should the probe be forced despite resistance, especially when the control wheels change position. Once the probe is properly positioned in the esophagus or stomach, the patient stops swallowing saliva, which should flow freely into lignin. The cause of referral should be diagnosed first.

Probe maneuvers are performed in accordance with the "three times R" rule:

1. Rotating the probe to the **r**ight (clockwise) shows the **r**ight side of the heart.
2. Turning the large control wheel to the **r**ight (clockwise) moves the tip of the probe **a**nteriorly.
3. Turning the small control wheel to the **r**ight (clockwise) moves the tip of the probe to the **r**ight (to the right side of the patient).

In the transverse section, the left side of the heart is located on the right side of the sector, while the posterior part is displayed at the top of the sector. In the longitudinal section, the upper part of the heart is located on the right side of the sector, while the posterior part is displayed at the top of the sector.

The following imaging planes are used: transverse plane (0° and 180°), longitudinal plane (90°), transverse anatomical plane (30–50°), and longitudinal anatomical plane (100–130°).

Depending on the setting depth, the following views may be distinguished:

- low esophagus (the probe is advanced approximately 30–35 from the teeth);
- mid esophagus (the probe is advanced approximately 30 cm from the teeth);
- high esophagus (the probe is advanced approximately 25–30 cm from the teeth);
- transgastric subcardiac (approximately 35–40 cm from the teeth);
- transgastric five-chamber (the probe is advanced deeper than in the subcardiac view and with a stronger anterior flexion of the probe);
- aortic (the probe is rotated at about 180°).

Transesophageal echo views

Low esophageal view in a transverse plane can visualize the right ventricular inflow tract and the coronary sinus orifice to the right atrium over the septal cusp of the tricuspid valve.

Mid esophageal view shows a four-chamber image in a transverse plane, a two-chamber view with left atrial appendage in a longitudinal plane, and three-chamber view in a longitudinal anatomical plane. This view is particularly useful for the assessment of all segments of mitral cusps, the left ventricular outflow tract, and the ascending thoracic aorta.

High esophageal view in a transverse plane can show the aortic valve and both atriums. A cross-section of the aortic valve is obtained in the transverse anatomical plane, allowing for a planimetric assessment of the area of its orifice. The left atrium, separated from the right atrium by

the atrial septum, is located above the valve. Left-to-right elements under the aortic valve are as follows: the tricuspid valve, the right ventricular outflow tract, the pulmonary valve and the pulmonary trunk. The ascending aorta, aortic orifice, and the proximal portion of the right coronary artery may be visualized in the longitudinal anatomical plane. Flexion of the tip of the probe to the right shows the pulmonary trunk with the valve. Rotation of the probe to the right may show the atrial septum with the foramen ovale; the left atrium is located above the septum, while the right atrium is located below the septum. The superior vena cava enters the right atrium at 3 o'clock, while the inferior vena cava enters the right atrium at 10 o'clock. By extending the probe slightly above the level of aortic cusps, the orifice of coronary sinuses may be visualized (the orifice of the left coronary artery at 2'oclock, and the orifice of the right coronary artery at 6 o'clock). After setting the angle of the section plane at 0–30° and flexing the tip of the probe anteriorly, the image of the left atrial appendage with the orifice of the left superior vena cava above, separated with a club-shaped structure, are shown. Inserting the probe slightly above the level of coronary sinuses, the ascending aorta, the superior vena cava at 11 o'clock adjacent to the aorta, and the orifice of the right upper pulmonary vein to the left atrium may be visualized in a transverse plane.

In the transgastric subcardiac view, flexing the tip of the probe anteriorly in a transverse plane will show the left ventricle in the short axis view at the level of the papillary muscles. The image of the left ventricle, left atrium and its appendage may be acquired in the longitudinal plane. A slight rightward rotation of the probe shows the left ventricular outflow tract with the aortic valve. This is practically the only projection allowing for flow velocity assessment in the left ventricular outflow tract and through the aortic orifice. Right heart cavities will be visible after significant rotation of the probe to the right. Right ventricular image is obtained in the transverse plane; increasing the plane angle up to 30° allows visualization of short-axis tricuspid valve; increasing the angle up to 90° will display a two-chamber right-ventricular view; while a higher plane angle will show the right ventricular outflow tract with the pulmonary valve.

In the transgastric five-chamber view, a characteristic five-chamber heart view may be acquired in the transverse plane. Increasing the angle of the plain shows a three-chamber left ventricular view.

Aortic projections are acquired by rotating the probe at about180°. Changing the depth of the probe in the esophagus will show the descending part of the aorta and the aortic thoracic arch in the transverse and the longitudinal plane. When examining a tortuous aorta, proper probe maneuvers adjusted to the plane of the section are needed.

Conflict of interest

The authors do not report any financial or personal connections with other persons or organizations, which might negatively affect the contents of this publication and/or claim authorship rights to this publication.

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