COMPREHENSIVE REVIEW

Safety of Transesophageal Echocardiography

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Since its introduction into the operating room in the early 1980s, transesophageal echocardiography (TEE) has gained widespread use during cardiac, major vascular, and transplantation surgery, as well as in emergency and intensive care medicine. Moreover, TEE has become an invaluable diagnostic tool for the management of patients with cardiovascular disease in a nonoperative setting. In comparison with other diagnostic modalities, TEE is relatively safe and noninvasive. However, the insertion and manipulation of the ultrasound probe can cause oropharyngeal, esophageal, or gastric trauma. Here, the authors review the safety profile of TEE by identifying complications and propose a set of relative and absolute contraindications to probe placement. In addition, alternative echocardiographic modalities (e.g., epicardial echocardiography) that may be considered when TEE probe placement is contraindicated or not feasible are discussed. (J Am Soc Echocardiogr 2010;23:1115-27.)

Keywords: Safety, Transesophageal, Echocardiography, Perioperative, Nonoperative, Complications, Contraindications

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Target Audience:
This activity is designed for all cardiovascular physicians and cardiac sonographers with a primary interest and knowledge base in the field of echocardiography; in addition, residents, researchers, clinicians, intensivists, and other medical professionals with a specific interest in cardiac ultrasound will find this activity beneficial.

Objectives:
Upon completing the reading of this article, the participants will better be able to:

1. Recognize the different risk profile for TEE in the operative and non-operative setting.
2. List the absolute and relative contraindications of TEE.
3. Recognize the common sites and mechanisms of potential injury related to TEE in both the adult and pediatric populations.
4. Appreciate the most common major and minor TEE-related injuries, including oropharyngeal, esophageal, and gastrointestinal injury.
5. Apply recommendations for the prevention of TEE-related orogastric, cardiovascular, and respiratory complications, and appreciate the echocardiographic alternatives to TEE.
6. Identify a subset of procedural risks more specific to the pediatric/infant population.

Disclosures:
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Estimated Time to Complete This Activity: 1 hour

Transesophageal echocardiography (TEE) has become a standard intraoperative diagnostic technique for the management of patients undergoing cardiac surgery[1-4] as well as other major surgical procedures (i.e., lung transplantation[5,6] liver transplantation,[7] and aortic surgery[8]). High-risk patients may also benefit from transesophageal echocardiographic monitoring in a variety of surgical settings (e.g., lung, renal, abdominal, and head, neck, and chest wall surgeries).[9] In addition, patients in intensive care units (ICUs)[10-13] or emergency rooms may profit from the diagnostic information on TEE that cannot be obtained by other modalities in a timely manner.[14-17] Recently, the American Society of Anesthesiologists and the Society of Cardiovascular Anesthesiologists Task Force on Transesophageal Echocardiography updated the practice guidelines for perioperative TEE to assist physicians in the appropriate application of TEE and to improve the outcomes of surgical patients.[9] These comprehensive guidelines focus on highlighting patient populations likely to benefit from TEE and also list relative and absolute contraindications to TEE probe insertion.

The American College of Cardiology Foundation and the American Society of Echocardiography, together with key specialty and subspecialty societies, published appropriateness criteria for TEE in a nonoperative setting in an effort to respond to the need

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Abbreviations
EGD = Esophagogastroduodenoscopy
GI = Gastrointestinal
ICU = Intensive care unit
TEE = Transesophageal echocardiography
TTE = Transthoracic echocardiography

for the rational use of imaging services.[18] In general, it is assumed that TEE is appropriately used as an adjunct or subsequent test to transthoracic echocardiography (TTE) when suboptimal images on TTE preclude obtaining a diagnostic study. The indications for which TEE may reasonably be the test of first choice include, but are not limited to, aortic pathology, cardiac valve dysfunction, percutaneous noncoronary cardiac interventions, infective endocarditis, atrial fibrillation or flutter, and embolic events.[18,19]

Although TEE is considered a safe and relatively noninvasive diagnostic technique, severe, even life-threatening complications have been reported (Table 1, Figure 1). The infrequency of serious complications and difficulties in evaluating rare events limit the identification of TEE-associated predictors of increased morbidity or mortality. Several retrospective studies involving larger patient populations have identified inherent risk factors associated with TEE. A literature search was conducted via Medline and PubMed (1966 to June 1, 2010), and the bibliographies of retrieved articles were also reviewed.

For practicing echocardiographers, it is important to be familiar with potential complications of TEE to allow a thorough risk-benefit analysis on an individual basis. This holds especially true for patients with preexisting gastroesophageal disease, for whom the decision about the benefit versus potential harm of TEE can be difficult.

In this review, we summarize the available literature pertaining to the risks, complication rates, and overall safety of TEE, with the goal of facilitating the identification of patients in whom alternative echocardiographic modalities or other invasive or noninvasive diagnostic strategies should be considered.

GENERAL CLINICAL EXPERIENCE OF TRANSESOPHAGEAL ECHOCARDIOGRAPHIC SAFETY

Reported rates of major TEE-related complications in ambulatory, nonoperative settings range from 0.2% to 0.5%. TEE-associated mortality has been estimated to be <0.01% (Tables 2 and 3).[20-23] These rates of adverse outcomes are comparable with those associated with gastroscopy or esophagogastroduodenoscopy (EGD), for which the overall risk for nonfatal complications is between 0.08% and 0.13%, and the reported mortality rate is approximately 0.004%.[24,25] In comparison with the use of TEE in a nonoperative setting, intraoperative TEE poses a slightly different risk profile, because it involves probe placement and manipulation in intubated patients under general anesthesia who have frequently received neuromuscular blocking drugs. These patients are unable to swallow to facilitate probe insertion and cannot respond to possibly injurious probe manipulations. Furthermore, several consecutive transesophageal echocardiographic examinations or continuous intraoperative monitoring might be required for a subset of surgical patients. Overall rates of TEE-related morbidity with intraoperative TEE, however, have been estimated to be similar to nonoperative patients and range from 0.2% to 1.2%.[26-29] In the largest study of intraoperative TEE–related complications to date, a single-center case series of 7,200 patients, Kallmeyer *et al.*[28] reported TEE-associated morbidity and mortality of 0.2% and 0%, respectively. In contrast, Lennon *et al.*[30] surveyed patients for later complications and suggested that rates of major gastrointestinal (GI) injuries (e.g., gastric laceration, hemorrhage, or perforation) could be as high as 1.2%. More than half of the complications presented >24 hours postoperatively, with one patient not presenting until day 11. The authors therefore suggested that the accurate assessment of overall risk for TEE may have previously been underestimated given a possible delay in the clinical manifestation of TEE-related GI injury.[30]

Table 1 TEE-related injuries

Site	Injury
Oropharyngeal	Lip bruising/laceration, loose/chipped tooth, displaced dentures, pharyngeal laceration, perforation of the hypopharynx, accidental tracheal intubation
Esophageal	Odynophagia, dysphagia, laceration/perforation, Mallory-Weiss tear
Gastric	Laceration/perforation, hemorrhage
Miscellaneous	Splenic laceration, compression of mediastinal structures, airway compromise, thermal injury/burn, tongue necrosis

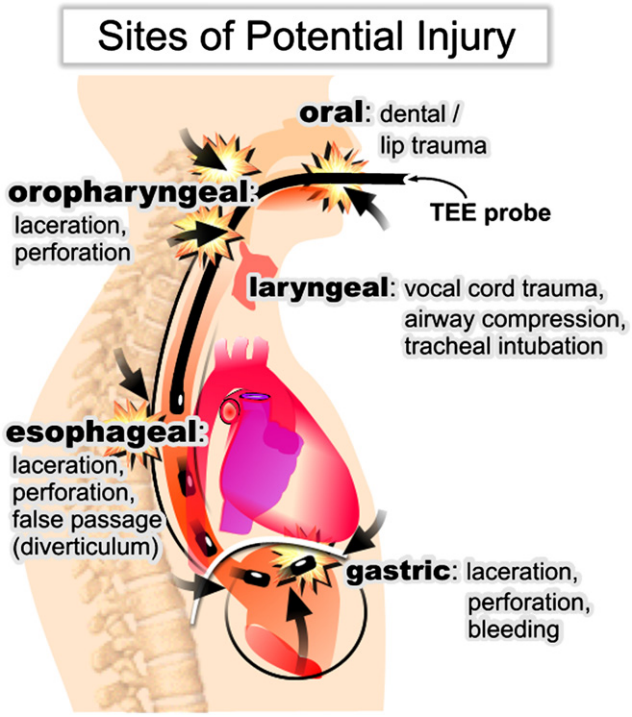

Figure 1 Sites of potential injury related to TEE include oral injury (e.g., lip or dental trauma), oropharyngeal injury (e.g., laceration, perforation), laryngeal injury (e.g., vocal cord trauma, compression of airway structures, inadvertent tracheal intubation), esophageal injury (e.g., laceration, perforation, false passage into diverticulum), gastric injury (e.g., lacerations or perforation particularly of fundus or gastroesophageal junction), and gastric bleeding.