Clinical Features of Complications From Transesophageal Echocardiography: A Single-Center Case Series of 10,000 Consecutive Examinations

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Background: Transesophageal echocardiography (TEE) is an essential diagnostic tool that has gained widespread use in clinical cardiology. It is considered reasonably noninvasive and safe; however, insertion and operation of the TEE probe may cause hypopharyngeal, esophageal, or gastric trauma. The current study reports a single-center experience of esophagogastric trauma in 10,000 consecutive TEE examinations.

Methods: TEE examinations were performed by 9 attending physicians who were trained in endoscopic procedures and had been performing TEE studies for at least 1 year.

Results: One case of hypopharyngeal perforation (0.01%), 2 cases of cervical esophageal perforation (0.02%), and no cases of gastric perforation (0%) occurred after TEE examination. No fatalities (0%) occurred. We describe the clinical characteristics of individuals who experienced esophageal perforation during this 10-year period.

Conclusions: This single-center study demonstrates that TEE examinations are associated with a very low risk of esophagogastric trauma when performed in a safe setting by experienced operators.

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Over the last decade, TEE has achieved widespread application in clinical cardiology. The increasing use of TEE stems from its real-time ability to evaluate myocardial function, cardiac valve performance, great vessel pathology, cardioembolic sources, intracardiac shunts, and overall hemodynamic state.

TEE is considered noninvasive and safe; however, insertion and manipulation of the TEE probe may infrequently cause oropharyngeal, esophageal, or gastric trauma. To date, few reports have considered the risk of hypopharyngeal, esophageal, and gastric perforation during consecutive TEE examinations in adult nonsurgical patients. Here we report the incidence and clinical features of TEE-associated esophagogastric trauma in a single-center series of 10,000 adult nonsurgical cardiology patients. We describe the clinical presentations and secondary complications associated with these perforations.

METHODS

The study population comprised 10,000 consecutive nonsurgical patients who underwent TEE between 1993 and 2004. In a random sampling of 100 patients, the average age was 54.7 years and 55 were male. The average body surface area was 1.92 m². Some 87% of the TEE examinations were performed in our echocardiography laboratory, with the remaining 13% performed in the emergency department or intensive care unit. Patients fasted for at least 4 hours before the examination. Examinations were performed under conscious sedation using a combination of a benzodiazepine (midazolam hydrochloride) or narcotic (fentanyl or morphine), which was prescribed at the discretion of the attending cardiologist. When possible, local oropharyngeal anesthesia was administered using viscous lidocaine. Patients were monitored with continuous telemetry and pulse oximetry. Blood pressure was measured every 5 minutes or more frequently when indicated. Before TEE probe insertion, a dental guard was inserted. Patients were placed in the left lateral decubitus position for the examination. A lubricated multiplane TEE probe (Philips, Andover, Mass) was then blindly inserted into the esophagus.

The average time of the TEE examination was typically less than 20 minutes. The potential risk-to-benefit ratio of the TEE exam was assessed for each patient. Relative contraindications included significant coagulopathy (INR > 2.5), esophageal or pharyngeal carcinoma, and esoph-
ageal or gastric varices. The TEE studies were performed only physicians who had training in routine endoscopy and were level-III certified (or eligible) in TEE by the American Society of Echocardiography. Following our laboratory’s protocol, the noninvasive cardiology fellow-in-training attempted the first 2 passages of the TEE probe. If these were unsuccessful, then the attending physician made any remaining attempts.

RESULTS AND CASE REPORTS

Esophageal trauma occurred in 3 of the 10,000 consecutive TEE examinations (0.03%). No fatalities occurred.

Patient 1

A 73-year-old Hispanic man (body mass index [BMI] 29.8) with a history of coronary artery disease and peripheral arterial disease presented with atrial fibrillation. After therapeutic anticoagulation with heparin, the patient was referred for TEE to rule out an intracardiac thrombus before electrical cardioversion was attempted.

After induction of conscious sedation with 4 mg midazolam hydrochloride and 100 μg fentanyl, the TEE probe was advanced into the esophagus. Intubation proved difficult and was attempted numerous times by 2 different operators before it was successful. Blood-tinged secretions were noted transiently but cleared promptly. Once the patient was intubated, the procedure proceeded smoothly.

Approximately 12 hours after the TEE examination, the patient experienced hemoptysis and mild shortness of breath. He was hemodynamically stable and had no oxygen requirement. Physical examination revealed crepitus on the anterior chest wall. Laboratory analysis at the time of the hemoptysis demonstrated an increase in white cell count from 6.3 K/μL to 17.7 K/μL. The hematocrit remained stable. No other significant changes in laboratory values were noted. Room air arterial blood gas analysis values were within normal limits.

A chest roentgenogram obtained at that time demonstrated soft tissue emphysema as well as a small pneumomediastinum (Figure 1, A). Chest computed tomography (CT) scan revealed a moderate amount of air throughout the tissues of the thorax (Figure 1, B). In the soft tissues above the sternal notch, a collection of subcutaneous air extended superiorly. Bilateral air collections were located along the posterior thoracic wall and medial to the scapulae. In the mediastinum, air surrounded the trachea and esophagus and extended inferiorly to the border of the aortic root. A fluid collection was located inferior to the trachea and lateral to the esophagus at the level of the aortic arch.

The otolaryngology service was consulted, and urgent surgical exploration was recommended. An irregular mucosal tear was identified in the left piriform sinus at the junction of the lateral and medial walls. A 4 × 4 cm encapsulated abscess flanked the mucosal tear. After debridement and irrigation of the abscess, the mucosal tear was sutured. A Penrose drain was placed, and the wound was closed without complication.

The patient did clinically well during the postoperative period. A barium esophogram before discharge demonstrated no contrast extravasation at any level of the oropharynx, pharynx, or esophagus. The patient was discharged in stable condition 19 days after his initial TEE examination.

Patient 2

A 79-year-old Caucasian man (BMI 25.2) with a history of peptic ulcer disease was admitted with a transient ischemic attack. A TEE examination was performed to rule out an intracardiac source of embolus. The patient was placed under conscious sedation with 3 mg midazolam hydrochloride and 100 μg fentanyl. The TEE probe was advanced with significant difficulty to the esophagus; multiple attempts were required. After successful intubation, the remainder of the TEE examination proceeded without problem. The patient’s vital signs remained stable during the procedure, and care was taken to suction oral secretions to avoid aspiration.

Approximately 4 hours after the procedure, the patient complained of a severe sore throat. He was hemodynamically stable and without significant oxygen requirement. Laboratory analysis revealed an increase in the white cell count from 9.6 K/μL to 12.6 K/μL, with an associated drop in hematocrit from 40.1% to 34.5%. A chest roentgenogram revealed new soft tissue emphysema in the left supraclavicular fossa and on the left side of the neck (Figure 2, A).

An esophagram demonstrated significant extravasation of barium contrast medium into the pharynx and hypopharynx through a penetrating injury of the left piriform sinus that was associated with

Figure 1 (A) Chest roentgenogram demonstrating significant neck subcutaneous emphysema (arrows). (B) Chest CT revealing air collections in the mediastinum and adjacent to the thoracic wall (arrows).
copious collection of contrast medium in the left lateral soft tissues. A swallowing study also demonstrated significant proximal esophageal aspiration of contrast medium.

An otolaryngology consult recommended conservative nonsurgical management. The patient did not consume anything by mouth, remaining stable until 60 hours after the TEE examination, when he began to experience respiratory distress and hypoxia. A CT scan revealed a large, soft tissue mass with multiple air collections in the left mediastinum that extended superiorly into the left parapharyngeal space, consistent with parapharyngeal abscess (Figure 2, B). No air was seen in the thoracic or cervical esophagus. Subpulmonic pleural effusions and ground-glass opacities in the lower lung lobes with frank airspace consolidation were present.

The patient went to surgery 72 hours after the TEE examination. Direct laryngoscopy revealed edema of the posterior pharyngeal wall, arytenoids, and piriform sinuses. A 1-cm mucosal laceration of the cervicopharyngeal mucosa with purulent discharge, bordered by an abscess cavity located lateral to the larynx and medial to the left great neck vessels, was noted. The abscess began at the level of the cricoid cartilage and extended inferiorly to the anterior mediastinum. The abscess cavity was debrided and copiously irrigated. A Blake drain was placed, and the wound was closed. The abscess cultures grew methicillin-resistant Staphylococcus aureus and Candida glabrata.

A barium esophagogram after the operation demonstrated no extravasation of contrast medium from the esophagus. The patient was advanced to a full diet before discharge. He left the hospital in stable condition 19 days after his initial TEE examination.

**Patient 3**

An 84-year-old Hispanic woman (BMI 17.8) with a history of gastroesophageal reflux disease was admitted with atrial flutter. She was therapeutically anticoagulated with heparin and referred for TEE examination before elective cardioversion.

The patient was placed under conscious sedation without difficulty with 3 mg midazolam hydrochloride and 25 μg fentanyl. Multiple intubation attempts with the TEE probe were met with resistance. A scant amount of blood-tinged saliva was noted transiently on the TEE probe. An additional attempt by a different operator resulted in successful intubation. The remainder of the TEE examination proceeded in a routine manner.

Approximately 22 hours after the TEE examination, the patient complained of shortness of breath accompanied by cough, odynophagia, and dysphagia. The patient was hemodynamically stable but with significant oxygen desaturation, to 84% on room air. Physical examination revealed crepitus of the anterior upper chest wall. Laboratory analysis demonstrated an increase in white cell count from 6.9 K/μL to 16.5 K/μL, with a concomitant drop in hematocrit from 39.7% to 35.5%.

A chest roentgenogram revealed a moderate-sized right pneumothorax and moderate bilateral pleural effusions, prompting the placement of a chest tube (Figure 3, A). The chest tube drained 700 mL of hemorrhagic fluid within 2 hours.

A CT scan revealed extensive subcutaneous and mediastinal air. Air and contrast medium were noted in the esophagus, which was flattened by a paraesophageal fluid collection posteriorly (Figure 3, B). The fluid collection exhibited a fluid level with hyperdense material layering posteriorly, findings compatible with a paraesophageal hematoma. Just above the level of the aortic arch, a small amount of extravasated contrast medium was seen to the right of the esophagus, identifying the area of presumed perforation. The large right pneumothorax was confirmed on the CT scan.

The thoracic surgery service recommended conservative nonsurgical management. After 24 hours, the patient remained dyspneic and hypoxic, producing persistent drainage from her chest tube. She was taken to the operating room approximately 56 hours after the TEE examination for further exploration. Under esophagogastrodudenoscopy (EGD) guidance, an esophageal perforation with associated hematoma was identified in the cervical esophagus. On entry of the chest space via a right thoracotomy, a large hematoma and generous amount of free-flowing blood were encountered. The mediastinal hematoma was evacuated, and hemostasis was achieved with electrocautery. Two chest tubes were placed, and the wound was closed.

The patient experienced an uncomplicated postoperative course, undergoing a barium esophagogram postoperatively that revealed no extravasation of contrast medium from the esophagus. She was advanced to a thick liquid diet while working with a...
Figure 3 (A) Chest roentgenogram demonstrating right-sided pneumothorax (arrow) and bilateral pleural effusions. (B) Chest CT revealing mediastinal air, paracesophageal fluid collections with fluid-fluid levels, and a right-sided pleural effusion (arrows).

speech pathology for dysphagia training. She was discharged in stable condition 20 days after her initial TEE examination.

DISCUSSION

This single-center study of 10,000 consecutive TEE examinations of adult nonsurgical patients demonstrates that the rate of hypopharyngeal, esophageal, or gastric perforation is exceedingly rare, occurring in only 0.03% of cases. No fatalities occurred during this study. These findings are consistent with those of previous studies of adult nonsurgical and surgical patients. In a multicenter study of 10,419 primarily nonsurgical patients undergoing TEE examinations, the overall complication rate was 0.18%, with 1 fatality. Kallmeyer et al reported an overall morbidity incidence of 0.2% with no fatalities in 7200 adult patients undergoing TEE during cardiac surgery. The incidence of esophageal perforation in this series was 0.01%. This rate is similar to that reported in series examining individuals undergoing EGD examination.

Injury to the oropharynx or esophagus during TEE examination is believed to result from excessive pressure generated by the probe or from structural esophageal abnormalities that make the tissue more prone to mechanical disruption. These abnormalities may include esophageal/gastric varices, tumors, strictures, or Mallory-Weiss tears and are often considered relative contraindications to TEE examination. The use of medications that may affect the integrity of the esophageal mucosa, such as steroids and bisphosphonates, have also been historically considered relative contraindications.

These factors considered to increase the risk of esophageal perforation are based primarily on presumption. The rate of esophageal perforation in both TEE and EGD procedures is sufficiently low to preclude systematic statistical analysis.

Notably, in our series, individuals experiencing esophageal perforation did not have any of the conventional risk factors. Certain shared characteristics were apparent, however. Each of the patients was elderly and not obese. Each individual suffering esophageal perforation did so after a difficult intubation that required multiple attempts and, in some cases, multiple operators. Esophagogastric trauma appeared to be unrelated to manipulation of the probe during the procedure. Each perforation was located in the hypopharynx or cervical esophagus, suggesting the perforations occurred at the time of intubation. Blood-tinged secretions were noted at the time of intubation in 2 of the 3 patients described, both of whom were actively anticoagulated at the time.

The manifestation of esophagogastric trauma after TEE examination may be immediate or delayed. In our series, perforation was not immediately apparent in any of the patients; the time to diagnosis of esophageal perforation ranged between 4 and 22 hours. Moreover, the modes by which the perforations became clinically evident varied. One patient presented with hemoptysis, 1 complained of odynophagia, and 1 exhibited dyspnea. The second patient’s odynophagia preceded the onset of the more clinically worrisome episode of dyspnea and hypoxia. Each of the patients in our series eventually presented with delayed dyspnea after esophageal perforation. Two of the patients developed severe subcutaneous emphysema that was palpable on physical examination.

At the time of presentation, each patient who suffered an esophageal perforation exhibited a rise in white blood cell count. Two of the 3 patients experienced a significant drop in hematocrit. Two patients developed significant hypoxia at the time of initial presentation.

The secondary complications that occurred related to TEE-related esophageal perforation were varied. Two patients developed abscess, only 1 of which involved pathological bacteria. One patient developed a significant hematothema with active and persistent esophageal bleeding. In all 3 patients, chest roentgenogram substantially aided the diagnosis of perforation. These roentgenograms prompted further radiographic studies, namely contrast CT scan and barium esophagram, which were invaluable in the prompt diagnosis of these diverse complications.

There are limitations to the current investigation. Despite the large number of patients studied, it remains the experience of a single center. However, the consistency of attending physicians ultimately responsible for performing TEE examinations at a single center may be more reflective of the type of experience that occurs within a single cardiology practice. Also, the review of patients experiencing complications from TEE was retrospective. It is not inconceivable that there were subclinical complica-
tions of TEE that were so minor as to preclude detection. However, in accordance with our laboratory’s protocol, 24-hour postprocedure follow-up was performed on all individuals for whom the TEE was considered more difficult than typically encountered. Consequently, we feel confident that the complications specified herein represent the totality of clinically significant complications.

Delayed dyspnea, cough, odynophagia, and hemoptysis are presenting features of esophageal perforation after TEE examination. Based on these observations, it should be encouraged to advise every patient undergoing TEE examination to immediately report any of these clinical characteristics, regardless of how mild they may be. Presentation of any of these clinical signs should prompt the physician to perform a systematic investigation without delay. This investigation should include laboratory analysis of white blood cell count and hematocrit, as well as radiographic study with chest roentgenogram and neck/chest CT. Early involvement with the appropriate surgical team is invaluable in the therapeutic resolution of these rare complications.

Conclusion

TEE is a very safe procedure. Esophageal perforation is an exceedingly rare complication, occurring only 0.03% of the time. In our series, esophageal perforation occurred in nonobese elderly individuals. Shared characteristics of clinical presentation, laboratory analysis, and radiographic studies were valuable to the prompt diagnosis and treatment of this complication.

REFERENCES