

Airway Obstruction by Transesophageal Echocardiography: Is Oblivion Bliss?



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INTRODUCTION

Transesophageal echocardiographic (TEE) imaging is considered a relatively safe and effective modality.¹ With an overall morbidity of 1.4%, the most frequently reported complications include gastrointestinal side effects such as odynophagia.² Airway complications from manipulation of the probe in the esophagus include accidental extubation and damage and migration of the endotracheal tube (ETT) in those who are mechanically ventilated.¹ Airway compression from TEE imaging, although a well-described complication in pediatric patients (1%–2%), is rarely observed in adults.¹ We describe complete airway obstruction caused by posterior compression from an ante-flexed TEE probe in an adult with undiagnosed tracheobronchomalacia, thus illustrating that TEE imaging may not be a benign procedure in this patient population.

CASE PRESENTATION

A medically complex 71-year-old woman (height 148 cm, weight 75 kg, body mass index 35 kg/m²) presented to the hospital with confusion, dyspnea, and a productive cough. She was found to have methicillin-sensitive *Staphylococcus aureus* bacteremia caused by infective vegetations seen on her implantable-cardioverter defibrillator device lead and community-acquired pneumonia. After antibiotic therapy failed to clear her blood cultures, the decision was made to pursue laser lead extraction. Her pertinent medical history included nonobstructive hypertrophic cardiomyopathy with reduced left ventricular ejection fraction (35%), normal right ventricular function, mild pulmonary hypertension, implantable cardioverter-defibrillator placement in 2004 for secondary prevention of ventricular tachycardia, and chronic obstructive pulmonary disease on home oxygen therapy. Computed tomography of her chest completed on admission to the hospital demonstrated diffuse emphysematous changes and chronic right middle lobe collapse of unknown etiology that had been noted 1 year prior.

After multiple attempts at laser lead extraction of the right ventricular lead failed because of dense adhesions, the decision was made to attempt surgical extraction via right thoracotomy and

peripheral institution of cardiopulmonary bypass. Supporting the decision to proceed with surgery was the suspicion that the tricuspid valve now harbored a vegetation that might require intervention. Intraoperative TEE imaging was therefore necessary to assess for tricuspid valve endocarditis and function and to guide potential valve replacement or repair.

Preoperatively, the patient was afebrile with an ongoing productive cough. Auscultation of her lungs revealed coarse breath sounds with an expiratory wheeze. Following standard induction of general anesthesia with fentanyl (4 µg/kg), etomidate (0.2 mg/kg), lidocaine (1 mg/kg), and rocuronium (1.2 mg/kg), the patient was easily intubated with an 8.0 ETT and placed on volume-controlled ventilation (tidal volume 6 mL/kg, positive end-expiratory pressure 5 mm Hg, respiratory rate 14 breaths/min, and 100% inspiratory oxygen). An adult-sized ultrasound probe was inserted for perioperative comprehensive TEE examination. While assessing the ascending aorta at upper esophageal locations, the patient's peak airway pressure suddenly rose, with a significant reduction of tidal volume, suggestive of an obstructive etiology (Figure 1, Video 1). The morphology of the patient's end-tidal CO₂ waveform also appeared suppressed and irregular with each respiration. Systematically evaluating for and treating the common causes of increased airway pressure, such as blockage of the ETT with secretions, bronchospasm, and abdominal tension from coughing and bucking due to lack of paralysis, resulted in temporary and little improvement. Examination with TEE imaging was eventually halted because of the ventilatory instability of the patient, which coincidentally restored normal mechanical ventilation. It was further discovered that even gentle ante-flexion of the TEE probe in the upper esophageal location consistently reproduced signs of airway obstruction as seen before.

Fiber-optic bronchoscopy was performed while the patient was on cardiopulmonary bypass to survey any anatomic changes in the airway with TEE probe manipulation without compromise to oxygenation and ventilation. The examination demonstrated (1) loss of longitudinal muscle fibers along the posterior tracheal mucosa, (2) abnormal appearance of anterior cartilaginous tracheal rings, (3) severe connective tissue invagination near the carina, and (4) near obliteration of the trachea lumen distal to the tip of the ETT with ante-flexion of the TEE probe (Figure 2, Video 2). TEE examination in the upper esophageal locations was avoided for the remainder of the surgery.

The right ventricular lead was extracted and a vegetation, adjacent to the anterior and posterior tricuspid leaflets, was excised, without having to intervene upon the tricuspid valve. The patient was successfully weaned from cardiopulmonary bypass, with moderate tricuspid regurgitation and mild right ventricular dysfunction. She was maintained on mechanical ventilation to be recovered in the cardiac surgery intensive care unit. Postoperatively, otolaryngology was consulted for diagnosis and potential intervention. Bronchoscopy was repeated while the patient was intubated, which not only confirmed intraoperative findings but also discovered dynamic end-expiratory airway collapse, leading to the final diagnosis

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VIDEO HIGHLIGHTS

Video 1: Real-time ventilator monitor showing acute changes in ventilatory parameters associated with TEE probe manipulation.

Video 2: Fiber-optic bronchoscopy through the ETT showing compression of the trachea with TEE antelexion in real time.

[View the video content online at www.cvcasejournal.com.](http://www.cvcasejournal.com)

of severe tracheobronchomalacia. The patient was extubated uneventfully within 24 hours to continuous positive airway pressure and discharged from the hospital 2 weeks later without further respiratory complications.

DISCUSSION

Airway compression from TEE probe manipulation is a rare but serious complication that should be present in the differential diagnosis when there is a sudden increase in airway pressure and impaired ventilation intraoperatively. There are several anatomic and pathophysiologic mechanisms to explain why this adverse event occurred. The esophagus runs immediately posterior to the trachea from the level of the cricoid cartilage down to the gastroesophageal junction. The posterior portion of the trachea is made up of fibroelastic membranes and muscle fibers, and therefore it is susceptible to external compression because of the lack of structural support by cartilage.³ When viewing cardiac structures anterior to the esophagus such as the ascending aorta, direct compression of a weakened trachea and left main bronchus by an antelexed TEE transducer is possible (Figure 3). Therefore, upper esophageal TEE views should generally be avoided or obtained with extreme caution under these

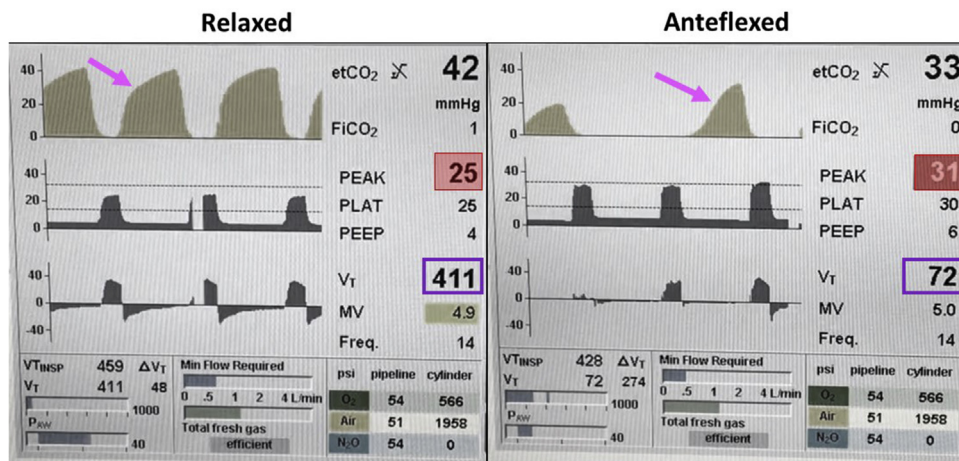


Figure 1 Screenshot of ventilator monitor showing an acute change in end-tidal CO₂ waveform (pink arrows), elevation of peak airway pressure (red box), and reduction of tidal volume (purple box) before and after the TEE probe is antelexed.

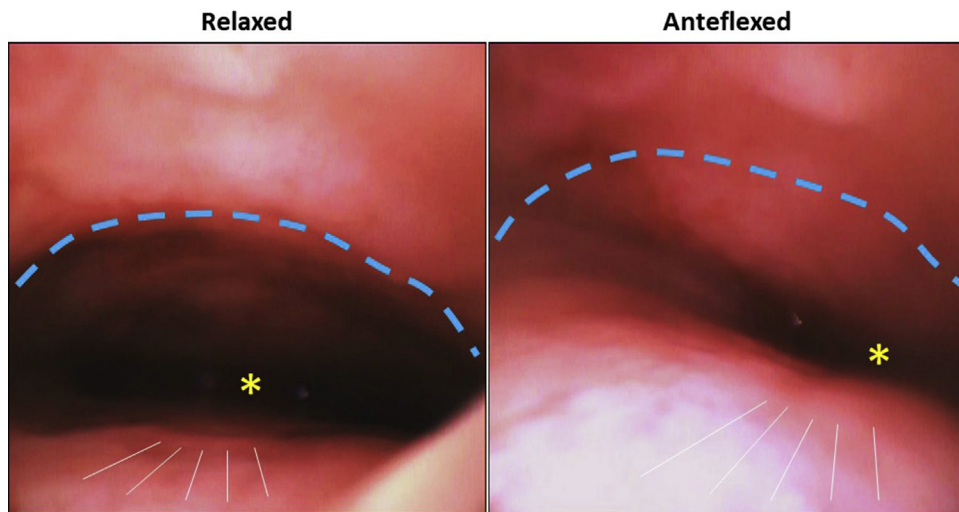


Figure 2 The pathologic distal trachea is compressed with antelexion of the TEE probe visualized in real time by fiber-optic bronchoscopy. Blue dotted lines show the abnormal tracheal rings, yellow asterisk depicts the tracheal lumen, and the white lines represent posterior longitudinal muscle fibers should they exist.

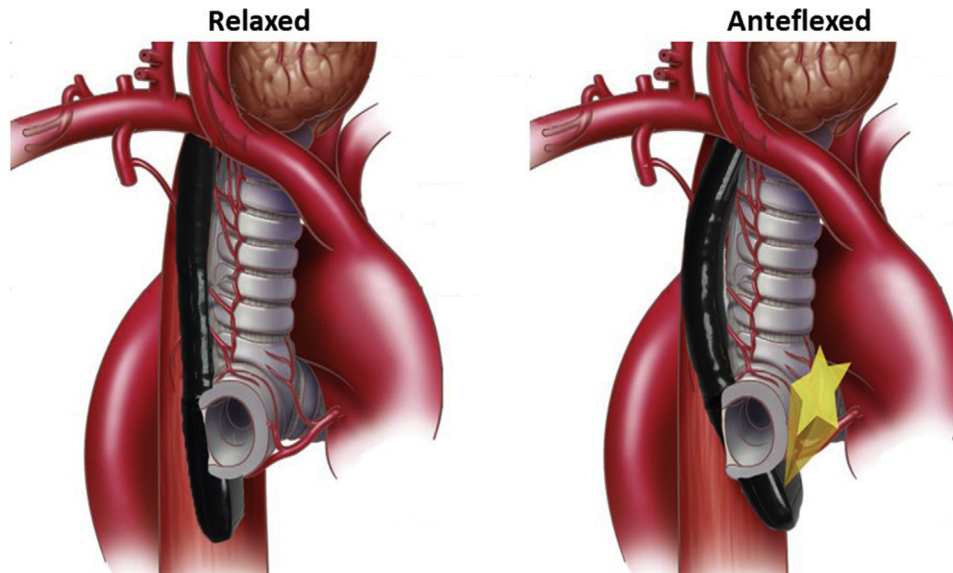


Figure 3 Illustration of the anatomic relationship among the trachea, esophagus, ascending aorta, and relaxed and anteflexed TEE probe. The *yellow star (right panel)* depicts the potential location of tracheal compression in a susceptible patient.

circumstances. Alternative ultrasonic imaging modalities such as epiaortic or epicardial echocardiographic examinations can be used should essential information be critical for intraoperative patient management.

Tracheobronchomalacia is common in adults, diagnosed in up to 23% of patients with chronic bronchitis and 1% of patients undergoing bronchoscopy for a variety of respiratory symptoms.⁴ Patients typically present with nonspecific symptoms, such as dyspnea, cough, wheezing, sputum production, and hemoptysis,⁴ that are often attributed to preexisting respiratory disease.³ It is caused by the atrophy of elastic fibers and/or weakening of cartilage, making the trachea and mainstem bronchi susceptible to collapse.⁴ When diagnosed in adulthood, it can be congenital or acquired from tracheostomy, prolonged intubation, chest trauma, malignancy, or, as in our case, severe emphysema and chronic bronchitis.³ Visualization under fiber-optic bronchoscopy of dynamic tracheal and or bronchial collapse $\geq 50\%$ on forced expiration by a spontaneously ventilating patient is currently the accepted “gold standard” in diagnosis.³ In intubated patients, positive pressure can act to stent open a diseased airway, making this diagnosis challenging.³ Treatment most commonly entails medical management of underlying respiratory comorbidities and, if symptoms persist, noninvasive positive pressure ventilation such as continuous positive airway pressure to reduce dynamic airway collapse.³ In rare circumstances, surgical options such as tracheostomy, stenting, and tracheal reconstruction have been described.³

Our case uniquely captured the dynamic interaction, by both ventilator parameter changes and fiber-optic bronchoscopy visualization, between the airway and the TEE transducer during a comprehensive examination. In our patient, the combination of tracheobronchomalacia and an inherently weaker posterior membranous tracheal wall compromised the integrity of the airway, leaving it vulnerable to external compression by the TEE probe. Other case reports describing airway compression in adults from TEE probe manipulation are generally in the context of preexisting displacement and compression by ascending aortic aneurysms.^{3,5} To date, there has been only one other report of posterior membranous trachea compression by TEE probe

anteflexion that was attributed to patient positioning (head flexion) and unique device features (softer and more compressible tip of a laryngeal mask airway).⁶

CONCLUSION

Although TEE imaging is generally considered safe, with few relative or absolute contraindications,^{1,7} probe insertion and manipulation within the esophagus must always be exercised with caution, as we have demonstrated unexpected airway complications in an undescribed yet susceptible group of adult patients.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.case.2020.02.002>.

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