Oesophagotracheal perforation after intraoperative transoesophageal echocardiography in cardiac surgery

J.-B. Lecharny*, I. Philip and J.-P. Depoix

Service d’Anesthésiologie et Réanimation Chirurgicale, Hôpital Bichat-Claude Bernard, 46 rue Henri Huchard, F-75018 Paris, France

*Corresponding author

Although transoesophageal echocardiography (TOE) can be considered a safe procedure, severe complications may occur. We report an oesophagotracheal perforation diagnosed 7 days after a complex and very long four-valve replacement procedure in a patient with a poor preoperative condition. We believe that an ischaemic lesion of the oesophagotracheal wall caused by the TOE probe was the initial event leading to this perforation. This observation raises concerns about the safety of prolonged TOE monitoring and suggests that a combination of risk factors (i.e. a small stature, a very long procedure, congestive heart failure, and a low cardiac output before and after cardiopulmonary bypass) may warrant increased precautions while performing TOE during cardiac surgery.

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Transoesophageal echocardiography (TOE) is routinely performed in the operating room in cardiac surgery. It is generally considered a semi-invasive technique with a very low rate of complications. We report here a fatal case of oesophagotracheal perforation diagnosed after intraoperative TOE monitoring in a 37-yr-old patient undergoing elective four-valve replacement at our institution.

Case report

The patient, a 37-yr-old man, weight 47 kg, height 1.70 m, was to undergo bioprosthetic valve replacement of the aortic, mitral, tricuspid, and pulmonary valves. Eight years earlier he had had a trivalvular bioprosthetic replacement (aortic, mitral, and tricuspid valves) with a
pulmonary valve repair for complex congenital and rheumatic heart disease.

Several weeks before the re-operation he presented with right ventricular (RV) failure. Degeneration of all three bioprostheses and severe pulmonary regurgitation was diagnosed using transthoracic echocardiography. The left ventricle was enlarged with a moderate reduction in left ventricular ejection fraction. The right ventricle was enlarged and hypertrophic. The pulmonary systolic pressure was 65 mm Hg. Preoperative oesophagogastroscopy was normal.

During surgery the patient was monitored with a radial artery catheter, a Swan-Ganz pulmonary artery catheter with $S_{O_2}$, and TOE. The ultrasound transducer (Multiplan V5M, Acuson, Mountain View, CA) was inserted without difficulty at the first attempt. A small nasogastric tube was inserted easily at the end of the surgical procedure.

The surgical procedure was complex and long, lasting 9 h including a total cardiopulmonary bypass (CPB) duration of 6 h at a mean arterial pressure of 50–70 mm Hg. The TOE probe remained in the oesophagus during the whole procedure. The tip of the probe was in the neutral position, at the level of the left atrium in the oesophagus, and the transducer was disconnected during bypass. CPB was uneventful.

Weaning from CPB was difficult because of a low cardiac output and pulmonary hypertension, which required an infusion of epinephrine and dobutamine and the insertion of an intra-aortic balloon pump (IABP). During the early postoperative period the patient remained unstable with bleeding and low cardiac output with RV failure. The mean arterial pressure was around 60–70 mm Hg for 36 h despite inotropic and vasoconstrictive pharmacological support. After 3 days of intensive care, IABP was removed and inotropic drugs were gradually withdrawn. The patient’s condition gradually improved but on postoperative day 7 he presented with clinical signs of shock and epinephrine had to be resumed. Bilateral pulmonary infiltrates appeared on the chest x-ray and the patient became severely hypoxemic. A gas leak became obvious during ventilator insufflations despite correct positioning of the orotracheal tube and an intact balloon cuff. During a fibre optic bronchoscopy (performed for broncho-alveolar lavage before antibiotic treatment) we found a 5-mm round hole surrounded by a pale ring of false membrane located at the posterior, membranous face of the tracheal bifurcation, just above the left main bronchus and we diagnosed an oesophago-tracheal perforation. Oesophageal mucous membrane was clearly seen through the hole. The rest of the tracheal and bronchial mucous membrane was normal. Broncho-alveolar lavage culture subsequently revealed a streptococcal pulmonary infection and one blood sample on the same day was positive for the same bacteria. A Blackemore oesophageal balloon catheter was inserted. Surgical repair was planned but the patient died a few hours later. An oesophagoscopy was not performed. The patient’s family refused an autopsy.

**Discussion**

TOE is used routinely in cardiology, cardiac surgery, and ICU for diagnostic or monitoring procedures. It is generally considered a safe and minimally invasive technique. However, adverse events may occur during insertion or manipulation of the probe. Serious complications are reported in less than 0.1% of TOE examinations with a mortality rate around 0.004% without definitive evidence of a direct link. TOE may be associated with gastrointestinal trauma, dysphagia, laceration, perforation, or haemorrhage. As far as we know, this is the first report of an oesophagotracheal perforation complicating this procedure.

Bleeding and perforations are mostly traumatic, occurring during probe insertion and are rapidly recognized.
during the early post-procedure period, leading to prompt surgical treatment. In our case, the complication became obvious only on the seventh postoperative day leading to a fatal bilateral pneumonia. Recently, Massey and colleagues reported the case of a fatal oesophageal perforation recognized on the fourth postoperative day, highlighting the difficulty of an early diagnosis of such a complication in intensive care patients. The principal risk factor for this perforation was gross cardiomegaly which displaced and thinned the patient’s oesophagus. As in our observation the delayed expression and recognition of the perforation contributed to the fatal outcomes.

In our case, the location of the perforation and its timing strongly support the hypothesis that the underlying pathophysiological mechanism was ischaemia of the oesophageal and tracheal mucous membranes caused by contact pressure between the echo probe and the tracheobronchial wall in a region of intimate proximity of the oesophagus and the tracheal bifurcation (Fig. 1). As documented by the preoperative endoscopy, the lesion occurred in a macroscopically normal oesophagus. The pressure caused by TOE probes was studied by Urbanowicz and colleagues. In their study, pressures were usually low (less than 17 mm Hg in five of six patients) thus avoiding ischaemia of the oesophageal mucous membrane, but in one patient the pressure went up to 60 mm Hg, which is in the range of the arterial pressure routinely achieved during CPB. In the case we describe, the small build of the patient, the very long surgical procedure, and congestive right heart failure with low cardiac output, hypotension and high venous pressure during and after surgery (except during CPB) may have provided favourable conditions for an initial ischaemic injury of the oesophageal and tracheal walls. The low perfusion pressure of the mucosa as a result of low arterial and high venous pressures that were still present long after the removal of the probe prevented healing of the initial lesion. Although possible and described previously, a thermal injury appears less likely as the echo transducer was disconnected during CPB and because of the security system of the echograph that turns off the transducer’s power when its temperature exceeds 41°C.

One might argue that the tracheal tube or tracheal suction catheters could have been responsible for the complication. A lesion caused by the tracheal tube was discounted as tracheal intubation was easy and because systematic precautions are routinely implemented in our ICU to avoid and detect any displacement of the tube. Daily chest x-rays were performed and the tip of the tube was positioned normally on all images, several centimetres above the tracheal bifurcation. Other than the perforation itself, the tracheal surface was free of lesions suggesting that tracheal suctioning was performedatraumatically. The nasogastric tube was of small diameter, easily inserted and its correct positioning was verified on each chest x-ray.

The very severe multi-valvular heart disease of the patient, his poor preoperative condition, and the unusual duration of the procedure should have led us to alter our routine procedure of intraoperative TOE monitoring. Although the insertion of the probe before weaning of CPB is often more difficult than immediately after anesthesia induction and tracheal intubation (interference with the surgical procedure, less easy use of a laryngoscope in case of unsuccessful blind insertion), we might have prevented this complication by removing the transoesophageal probe during CPB.

Guidelines have been published regarding the intraoperative use of TOE. We performed TOE in this case in accordance with these recommendations. There were no contraindications to TOE in this case (in particular the preoperative oeso-gastro-duodenoscopy was normal) and no technical difficulty was encountered for insertion and positioning of the probe. However, we believe that very long TOE monitoring procedures in fragile patients should lead to increased precaution regarding the management of the echographic probe.

References
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