Oesophageal perforation following perioperative transoesophageal echocardiography

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Transoesophageal echocardiography (TOE) is being used more often by cardiothoracic anaesthetists for the perioperative management of cardiac problems. Reports of iatrogenic oesophageal perforation by instrumentation of the oesophagus are increasing.1 Although TOE is considered safe,2 3 it may be more risky during surgery, because the probe is passed and manipulated in an anaesthetized patient. It may be in place for several hours so the risk of mucosal pressure4 and thermal damage is increased. Patients on cardiopulmonary bypass are also fully anticoagulated. We describe a case of oesophageal perforation following insertion of the TOE probe in a patient with gross cardiomegaly. Oesophageal distortion by cardiac enlargement may increase the risk of oesophageal perforation. Difficulty in passage of the TOE probe should be regarded with suspicion and withdrawal should be contemplated because the symptoms of oesophageal perforation are often delayed5 and non-specific.1 Delay in investigation, diagnosis and treatment will increase morbidity and mortality. 6–8

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Transoesophageal echocardiography (TOE) is being used increasingly by cardiothoracic anaesthetists in the UK. We describe a case of iatrogenic oesophageal perforation after perioperative insertion of a TOE probe in a patient with gross cardiomegaly.

Case report

A 59-yr-old woman with severe rheumatic mitral valve disease was admitted for mitral valve repair or replacement and tricuspid valve repair. She had severe mitral regurgitation, a dilated and severely globally impaired left ventricle, pulmonary hypertension (52/28 mm Hg) and normal coronary arteries. Chest x-ray showed gross cardiomegaly with a heart:chest ratio of 1 and a splayed carina (Fig. 1). She had audible inspiratory stridor during normal conversation but gave no history of regurgitation or dysphagia. After peripheral venous and arterial cannulation, anaesthesia was induced with fentanyl, midazolam and etomidate. A right internal jugular central venous catheter and a Swan–Ganz introducer sheath were then inserted. The TOE probe (Hewlett-Packard Omniplane) was inserted into the oesophagus easily under direct vision using a laryngoscope. Resistance to passage was felt at 30 cm and no effort was made to pass the probe further. TOE at this level revealed a huge left atrium 16.5 cm in diameter (Figs 2, 3). Further preoperative assessment was made using transthoracic echocardiography.

The mitral valve annulus was 45 mm diameter. The mitral valve was replaced by a Medtronic Intact porcine bioprosthesis, with preservation of the posterior leaflet. A very thin friable left atrial wall was noted and there was considerable bleeding from the left atriotomy, which was controlled with difficulty. The cardiopulmonary bypass time was 2 h 48 min. Epinephrine, norepinephrine and enoximone were used during separation from bypass. She was extubated the following morning. A nasogastric tube was not used after the operation.

She progressed well and was eating normally until she complained of severe right pleuritic pain on the fourth postoperative day. Chest x-ray showed a large right pleural effusion which drained 2.5 litres of milky fluid. Later the same day she became unwell with hypotension, dyspnoea, oliguria and rapid atrial fibrillation. Mechanical ventilation was commenced. By the next day, 7000 ml of increasingly thick, offensive fluid had drained from the chest drain. At oesophagoscopy, a 5-cm oesophageal tear was found, starting 34 cm from the incisors, with an adjacent abscess cavity.
Fig 1 Chest radiograph demonstrating gross cardiomegaly with heart/chest ratio of 1 and a splayed carina.

Fig 2 Transoesophageal echocardiogram with multiplanar probe at the level of the left atrium and left atrial appendage. The size of the atrium is 16.0×10.9 cm (see centimetre measurement marks). LA = left atrium.

Fig 3 Transoesophageal echocardiogram with the multiplanar probe at the level of the left atrium and left atrial appendage. The plane of imaging has been rotated through 90°, producing a longitudinal view of the grossly enlarged left atrium. LA = left atrium; LV = left ventricle.

Discussion

TOE is widely used in North America for cardiac surgical management. The American Society of Anesthesiologists and the Society of Cardiovascular Anesthesiologists Task Force practice guidelines define three categories of perioperative TOE indications91 0 (Table 1). Each category is defined by the degree to which expert opinion, and evidence, show that TOE can improve outcome. TOE is being used more by anaesthetists in the UK. The indications for our use of TOE were category IIA and IIB. TOE is considered to be safe.23 In a multicentre study of 10 219 successful TOE probe insertions2 there was only one death, from an invasive lung tumour and haemorrhagic complications. However, of the total studied (10 419) only 11.9% were perioperative.

In perioperative cardiac TOE the probe remains in situ for several hours, during which time the patient is fully anticoagulated on cardiopulmonary bypass. In addition, the probe is inserted and manipulated in an anaesthetized patient who cannot indicate discomfort. Urbanowicz and colleagues found that the TOE probe may cause mucosal ischaemia by direct pressure of up to 60 mm Hg. 4 Leaving the tip flexed and locked for periods of time may also increase any ischaemia. When active, the probe becomes warm and could cause damage if it were used continuously for a long time.

At surgery, the oesophagus was friable, oedematous and displaced laterally, stretched around the enlarged left atrium. Despite defunctioning of the oesophagus by a cervical oesophagostomy, gastrostomy and drainage of the mediastinum, the patient deteriorated and died on the ninth day after the operation.

At post-mortem the oesophagus was noted to be very thin and friable, with associated inflammation around the tear. The oesophagus was distended around the left atrium with fibrosis and tethering.

There are seven published cases,2 11–16 including one death, of gastrointestinal tract damage from TOE. Three were mucosal lacerations occurring after uneventful perioperative TOE.11–13 All presented immediately after operation with blood aspirated from a nasogastric tube, passed routinely, after removal of the TOE probe. Two cases of haemorrhage occurred from oesophageal contusions.2 14 These presented 30 h and 4 days after non-perioperative
Oesophageal perforation after transoesophageal echocardiography

Table 1 Indications for the use of TOE10

<table>
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<tr>
<th>Category I: supported by the strongest evidence or expert opinion</th>
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<tr>
<td>Perioperative</td>
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<td>A Haemodynamic disturbance</td>
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<tr>
<td>B Valve repair</td>
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<tr>
<td>C Congenital heart surgery</td>
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<tr>
<td>D Thoracic aortic aneurysms, dissection or disruption</td>
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<td>E Hypertrophic obstructive cardiomyopathy</td>
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<td>F Endocarditis</td>
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<tr>
<td>G Assessment of aortic valve function in repair of aortic dissection</td>
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<tr>
<td>H Intensive care unit investigation of unstable patients with unexplained haemodynamic disturbances, suspected valve disease or thromboembolic problems</td>
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<tr>
<td>I Pericardial window procedures</td>
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<td>J Minimally invasive cardiac surgery</td>
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<th>Category II: supported by weaker evidence and expert consensus</th>
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<tr>
<td>Perioperative</td>
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<tr>
<td>A Patients with increased risk of myocardial infarction</td>
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<tr>
<td>B Patients with increased risk of haemodynamic disturbance</td>
</tr>
<tr>
<td>C Monitoring placement and function of assist devices</td>
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<tr>
<td>D Assessment of patients with suspected acute thoracic dissections aneurysms or disruption</td>
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<th>Category III: little scientific or expert opinion support</th>
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<tr>
<td>Intraoperative</td>
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<tr>
<td>A Evaluation of repair of cardiac aneurysm</td>
</tr>
<tr>
<td>B Evaluation of removal of cardiac masses</td>
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<tr>
<td>C Detection of foreign bodies</td>
</tr>
<tr>
<td>D Detection of air emboli during cardiotomy, heart transplantation and upright neurosurgical procedures</td>
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<tr>
<td>E Intracardiac thrombectomy</td>
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<td>F Pulmonary embolectomy</td>
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<tr>
<td>G Suspected cardiac trauma</td>
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<tr>
<td>H Repair of thoracic aortic dissection without suspected aortic valve involvement</td>
</tr>
<tr>
<td>I Detection of aortic atheromatous disease or other sources of aortic emboli</td>
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<tr>
<td>J Evaluation of pericardial surgery</td>
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<td>K Evaluation of anastomotic sites during heart and/or lung transplantation</td>
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Unfortunately, iatrogenic oesophageal perforations are increasing.17 Unless there is a very high index of suspicion, the diagnosis of perforation is often delayed or missed.1 5 Meckler’s triad, of vomiting, pain and subcutaneous emphysema, relating to spontaneous oesophageal perforation, is often absent. The patients are often symptom-free for several hours and 33% of initial chest x-rays are normal.5 Oesophagography is the most sensitive investigation, demonstrating over 90% of perforations.5 7 This may be improved by performing the investigation in the lateral decubitus position.17

A delay in diagnosis increases morbidity and mortality,6 7, although the 24-h watershed after which surgical outcome is poorer has been brought into doubt by a recent report with 10% mortality compared with the normal 25%.8 Other complications of TOE include bradycardia,18 ventricular tachycardia,2 third-degree heartblock,2 atrial fibrillation,2 angina,2 upper airway obstruction,19 20 fatal embolization of the right atrial mass,21 hypoxia,2 bronchoconstriction,2 and death from cardiac tamponade during TOE for aortic aneurysm dissection.22 There is also an association between perioperative TOE and postoperative swallowing dysfunction.23

Our patient died of an oesophageal perforation caused, presumably, by attempted passage of a TOE probe. Later discussion with the family revealed that the patient had actually complained of dysphagia. This is a contraindication to TOE, as is any oesophageal or gastric disease.10 24 This was unfortunately not noted by the anaesthetic or surgical assessments.

Severe cardiac enlargement can displace and thin the oesophageal wall. Oesophageal barium studies might indicate increased risk of oesophageal perforation in these patients. Should resistance to passage of the TOE occur, the probe should be withdrawn from this position.

Between active imaging, the TOE should be left in situ, in an unlocked position, with the probe head non-active to prevent thermal injury.

Oesophageal perforation has a better prognosis if diagnosed and treated early.6 Iatrogenic perforations do not give symptoms for many hours, and the first postoperative chest x-rays are often normal.5 Our patient was symptom-free until the fourth day after operation, when she was eating and drinking normally.
Difficulty in passing the TOE probe, or a bloodstained gastric aspirate after removal of the probe, should indicate early investigation, diagnosis and surgical treatment to reduce the high risk of morbidity and mortality.

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Mallory–Weiss tear following cardiac surgery: transoesophageal echoprobe or nasogastric tube?

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A case of fatal upper gastrointestinal bleeding from a Mallory–Weiss tear after transesophageal echocardiography during cardiac surgery is reported. After the echocardiographic examination, which is considered a safe procedure, a nasogastric tube was inserted which immediately revealed bright red blood. Eventually the patient lost 9 litres of blood. The role of the echoprobe and the nasogastric tube in causing the Mallory–Weiss tear is discussed. Although
this case is not conclusive about the mechanism of oesophageal damage, it is suggested that the safety recommendations for transoesophageal echocardiography also apply for instrumentation of the oesophagus with a nasogastric tube after the transoesophageal echocardiographic examination.

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Transoesophageal echocardiography (TOE) is increasingly used in cardiology and cardiac surgery with few reported complications. In cardiological practice TOE is considered to be a short, semi-invasive diagnostic procedure with a complication risk of 0.5–1% in large series.1 2 Although most complications are usually transient (e.g. cardiac dysrhythmias, hypotension, dysphagia and laryngospasm), upper gastrointestinal bleeding is potentially dangerous, especially in the setting of cardiac surgery because of the anticoagulation and coagulopathy associated with cardiopulmonary bypass (CPB). The increased contact time between the oesophagus and the TOE probe in the anaesthetized patient during surgery and the longer duration of a flexed probe position for continuous monitoring of left ventricular function may provoke oesophageal mucosal damage. However, overt upper gastrointestinal bleeding following TOE during cardiac surgery has rarely been described.3 4 We present a patient with fatal massive bleeding from a distal oesophageal lesion, diagnosed as a Mallory–Weiss tear, which occurred following TOE monitoring for cardiac surgery.

Case report

A 74-yr-old man underwent coronary artery bypass grafting for progressive three-vessel disease. He had moderate chronic obstructive pulmonary disease and had suffered a myocardial infarction 1 yr earlier. The preoperative transthoracic echocardiogram showed a moderately impaired left ventricular function. The patient denied a history of coagulopathy, alcohol abuse or gastrointestinal complaints, including oesophageal disease. Medication consisted of lisinopril, bisoprolol, furosemide, aspirin, ipratropium bromide and budesonide. Aspirin was stopped 2 days before admission to hospital. After induction of anaesthesia, a TOE multiplane probe (Vingmed, Sonotron, Zoetermeer, The Netherlands, tip dimensions: diameter 15.7 mm, length 44 mm) covered by a well-lubricated protective sheath was uneventfully inserted. The controls of the probe were in the neutral position to allow the probe to follow the natural course of the oesophagus. Images of the heart were obtained from the standard positions (mid-oesophageal and transgastric views). The angular fixation device to lock the probe was not used. The acoustic power control of the echomachine was in the default setting.

Revascularization of the myocardium was performed with a left internal mammary artery and a saphenous vein graft. TOE was used to guide weaning from CPB which necessitated ionotropic support (dopamine 10 µg kg–1 min–1). Heparin action was reversed with protamine which resulted in an activated clotting time of 107 s, comparable to the pre-CBP value. No signs of active bleeding existed in the surgical field. At the end of the operation, no gross fluid levels were seen in the stomach and the TOE probe was carefully removed after ~ 2.5 h. It was perfectly clean without any sign of blood. Thereafter, a 16F nasogastric tube at room temperature (Sherwood Medical, ‘s Hertogenbosch, The Netherlands) was inserted. The first attempt failed to pass the pharyngeal structures, but a second attempt resulted in a smooth introduction without obvious resistance. Suction was applied to verify the position and immediately 100 ml of bright red blood without clots was seen. The patient was transferred to the intensive care unit where again suction was applied to the nasogastric tube and another 500 ml of bright red blood was removed. The bleeding was refractory to therapy which consisted of iced saline flush, and resulted in a blood loss of 3 litres in the next 2 h. Endoscopy was performed and demonstrated small superficial upper gastric and prepyloric erosions, which could not be identified as a bleeding site, and several haematomas without sign of recent bleeding in the proximal oesophagus. At the gastro–oesophageal junction a bleeding lesion was seen in the wall of the oesophagus, which was diagnosed as a Mallory–Weiss tear and was infiltrated with 5 ml of adrenalin solution (100 µg ml–1). Because the bleeding continued, endoscopy was repeated and it was decided to insert a Sengstaken tube. Gradually the bleeding stopped after a total blood loss of 9 litres. No bleeding was observed from other sites and laboratory tests showed normal clotting values (APTT 29 s, PT 17 s, fibrinogen 1.5 g l–1). After 5 days, endoscopy was repeated showing no signs of haematomas in the proximal oesophagus and varices grade 1 in the distal oesophagus. The gastro–oesophageal junction was not seen due to a large black clot. The gastric mucosa was normal and no signs of active bleeding were present. Secondary to the concomitant massive transfusion, the patient developed a respiratory distress syndrome, a low cardiac output state and renal failure. Eventually the patient died on the 90th postoperative day due to multi-organ failure.

Discussion

This case describes a patient with massive bleeding from a Mallory–Weiss tear, which occurred following TOE during...
cardiac surgery. Mallory–Weiss tears occur at the gastro–oesophageal junction, indicating that this is a vulnerable area for mucosal lesions. Iatrogenic Mallory–Weiss tears resulting from upper gastrointestinal endoscopy have an incidence of 0.07–0.5%. In most patients, bleeding from these tears stops spontaneously and is managed nonsurgically, but blood loss may be considerable. TOE is a rapidly evolving technique and we use it in our institution as a routine technique for all cardiac procedures according to the recently published Practice Guidelines for Perioperative TOE, category I and II. Our patient met the criteria for cardiac surgery is longer than in cardiological practice, a nasogastric tube may have contributed to oesophageal mucosal damage, it is difficult to assess the magnitude of contribution to laceration or tearing.

What could have caused the Mallory–Weiss tear in our patient? The insertion of the TOE probe was uneventful and no excessive force was used to advance the probe, nor was the probe advanced with a flexed tip, thereby minimizing the risk of injury to the oesophagus during insertion. A review of the examination tape revealed no gross fluid levels in the stomach at the end of surgery and the protective sheath of the TOE probe was not bloodstained on removal, indicating that no significant bleeding up to that moment existed. It seems highly unlikely that all of the blood could have been wiped off the protective sheath by removal of the TOE probe from the oesophagus. Immediately after removal of the TOE probe a nasogastric tube was inserted as is routine in postoperatively ventilated cardiac patients to achieve gastric decompression and to prevent the accumulation of gastric contents due to their opioid anaesthesia. The insertion of the nasogastric tube was followed by the aspiration of bright red blood. This sequence of instrumentation of the oesophagus is basically the same as in two other case reports on significant gastrointestinal bleeding after an intraoperative TOE examination, but in those cases the bleeding was attributed solely to the instrumentation of the oesophagus with the TOE probe. Although the insertion of a nasogastric tube may have contributed to oesophageal and gastric mucosal damage, it is difficult to assess the magnitude of contribution to laceration or tearing.

Many of the reported complications of TOE could result from pressure exerted by the tip of the probe on the oesophagus and the stomach. It has been shown that generally oesophageal contact pressure exerted by a TOE probe is low and does not exceed 17 mm Hg in various positions, but that unexplained high pressure up to 60 mm Hg can occur. Moreover, it has been shown that in obtaining the left ventricular short axis view in 73% of patients the tip of the TOE probe was located in the stomach, in 14% at the gastro–oesophageal junction and in 13% in the oesophagus. To obtain this short axis view the TOE probe has to be flexed, and puts the gastro–oesophageal junction, which acts as a hinge for the TOE probe, at risk of pressure lesions. This raises concern for the apical four-chamber view which requires extreme flexion and may result in gastric laceration. In our patient, small upper gastric erosions were observed at endoscopic examination, but the apical four-chamber view was not used. Although the average contact time of the TOE probe during cardiac surgery is longer than in cardiological practice, a long contact time has not been shown to cause oesophageal mucosal damage in animal studies. Thermal injury as a contributing factor is unlikely, as the acoustic power was in the default setting, the ultrasound was used only for short examinations and the echoprobe was protected from temperatures exceeding 40°C by automatic shut-down. The effect of a latex protective sheath covering the TOE probe and its possible folds on the mucosa of the oesophagus is unknown. Residual coagulopathy after cardiac surgery is a possible contributing factor, but after reversal of heparin a normal clotting was achieved. The same applies for the residual effect of the use of aspirin. Furthermore, TOE can even be safely performed in patients undergoing liver transplantation, known for their coagulopathies and oesophageal varices.

In conclusion, the potential for oesophageal damage from TOE examination during cardiac surgery is illustrated in a patient with fatal bleeding from a Mallory–Weiss tear. Although our case is not conclusive about the mechanism of oesophageal damage, instrumentation of the oesophagus with either a TOE probe or a nasogastric tube after TOE probe removal is a potential risk factor for oesophageal bleeding after TOE examination during cardiac surgery. To ensure the safety of TOE, several basic rules should be observed: inspection of the probe prior to insertion for cleanliness and structural integrity; gentle introduction and positioning of a well-lubricated probe; avoidance of advancing the probe forcibly or manipulation with the tip in a locked position or leaving the tip flexed for a prolonged period of time. Therefore, we suggest that the recommendations for safety in TOE (including gentle insertion and positioning) also apply for instrumentation of the oesophagus with a nasogastric tube after TOE examination.

References
Mallory–Weiss tear


