There are approximately 2000 open oesophagectomy operations performed in the UK each year and most of these are for treatment of oesophageal cancer. The operation carries a 30-day mortality of 10% and the 5-year survival is approximately 25%.

Aetiology and pathology of oesophageal cancer
Oesophageal cancer is the seventh commonest malignancy world-wide. It occurs predominantly in those over 50 years-of-age and its incidence increases with age. Approximately 80% of cases are male. There are two main histological subtypes; cancers of the upper third of the oesophagus are mainly of squamous cell origin and those of the lower third are more likely to be adenocarcinoma. Overall, squamous cell carcinoma is more common accounting for over 80% of all primary oesophageal cancers. However, there are geographical and ethnic variations in distribution. Squamous cell carcinoma is most common in China and Iran, and in black compared with white Americans. In Europe and US, adenocarcinoma has increased in frequency in recent years such that both subtypes now have a similar incidence. The main risk factors for oesophageal cancer are poverty, poor nutrition, alcoholism and smoking. Of the intrinsic oesophageal diseases, achalasia and Plummer-Vinson syndrome are associated with squamous cell carcinoma and Barratt’s oesophagitis is associated with adenocarcinoma.

The world-wide distribution of tumours along the oesophagus is upper third 10–20%; middle third 50% and lower third 30–40%. By the time of presentation, local invasion of the tumour into neighbouring structures (e.g. the trachea, pericardium or aorta) is common and metastasis to regional lymph nodes, a major determinant of survival, is seen in more than 50% of patients. The most frequent sites for distant metastases are lung (30–50%) and liver (20–50%). Only one-third of patients are suitable for surgical resection with curative intent at the time of their diagnosis.

Surgery
Oesophagectomy can be approached by either a right or left transthoracic (TTO) or a transhiatal (THO) incision. The transthoracic approach allows good visualisation for en-bloc removal of the oesophagus and adjacent lymph nodes and, perhaps, is more likely to result in a cure. It is usually facilitated by one-lung ventilation. A right thoracotomy with laparotomy, the classical Ivor-Lewis approach, is suitable for tumours within the upper two-thirds of the oesophagus and a left thoraco-abdominal incision is suitable for tumours within the lower two-thirds. The transhiatal approach involves resection of the intrathoracic oesophagus through laparotomy and left neck incisions without recourse to a thoracotomy and is best suited for palliation of tumours below the level of the carina.

Morbidity and mortality
The hospital mortality for oesophagectomy is 10%, but ranges from > 20% in hospitals with fewer than 10 operations each year to < 5% in those with more than 50. Improved operative outcome has been related to the experience of the individual surgeon, but it is evident that better results cannot be achieved without an increase in the experience of the whole team. The morbidity following oesophagectomy is high (respiratory complications 25%, cardiovascular complications 12%, anastomotic leak 16%). The incidence of pneumonia is
higher following the transthoracic approach (TTO 18% vs THO 13%), which lends weight to an argument for the transhiatal approach for patients with chronic pulmonary disease. However, the transhiatal approach has a higher incidence of anastomotic leaks (TTO 10% vs THO 16%) and recurrent laryngeal nerve palsy (TTO 4.8% vs THO 11.2%). The 30-day mortality is TTO 9.5% vs THO 6.3% and the 5-year survival is TTO 26% vs THO 24%.

Risk for morbidity and mortality

Risk has mainly been analysed retrospectively and against either all complications, pulmonary complications or the development of acute respiratory distress syndrome (ARDS). Amongst the pre-operative risk factors, indices of poor cardiopulmonary function have been most commonly identified e.g. smoking, pulmonary dysfunction, reduced vital capacity, low pre-operative arterial oxygen tension and poor cardiorespiratory performance. Less consistent in correlation have been age, low body mass index and liver cirrhosis or dysfunction. The impact of pre-operative chemotherapy and radiotherapy on the outcome of oesophagectomy has not yet been defined. Operative risk factors are hypoxaemia and cardiovascular instability as defined by hypotension, blood loss or the requirements for fluid and blood transfusions. Postoperative risk factors include anastomotic leak, the length of time in receipt of mechanical ventilation and requirement for inotropic support.

Pre-operative assessment and preparation

Pre-operative scoring

Bartels and co-workers devised a pre-operative scoring system for oesophagectomy. They studied all pre-operative investigations from more than 800 of their patients and found that parameters in four systems (general status, cardiovascular, pulmonary and hepatic) gave the most useful information. Each system was scored as normal = 1, compromised = 2 or severely impaired = 3. They then multiplied this score by a risk factor for each system, so giving a composite score for each patient (Table 1). The patient’s total score was then used to classify them into low, moderate or high-risk groups that correlated with their risk of 30-day mortality. This scoring system has limitations; it was based on retrospective analysis and performed at a single centre so may not be universally applicable. Nevertheless, it can be used to help determine the appropriate level of postoperative nursing dependency for the patient.

| Table 1 Scoring system linking pre-operative status with postoperative risk |
|---------------------------------|-------------------|-----------------|-----------------|
| System (risk factor)            | Normal (1)        | Compromised (2) | Severely impaired (3) |
| General status (4)              | 4                 | 8               | 12               |
| Cardiovascular (3)              | 3                 | 6               | 9                |
| Pulmonary (2)                   | 2                 | 4               | 6                |
| Hepatic (2)                     | 2                 | 4               | 6                |
| Score                           | 11–15 Low         | 16–21 Moderate  | 22–33 High       |
| 30-day mortality               | 2%                | 5%              | 25%              |

General status

The general status of patients may be poor due to nutritional deficits and those with swallowing difficulties may have already suffered significant weight loss. In addition, many patients may have had various oncological treatment regimens shortly before their operation. The immunosuppressive effects of radiotherapy and chemotherapy influence postoperative morbidity; they can affect anastomotic healing, and increase the incidence of respiratory problems and sepsis. The window of opportunity following neo-adjuvant treatment (i.e. the time interval between treatment and surgery to balance correctly optimum tumour response and minimise treatment related morbidity) is as yet unclear. However, it is generally considered to be 4–6 weeks.

Cardiopulmonary system

There is a high incidence of cardiovascular and chronic respiratory disease amongst patients undergoing oesophagectomy. In addition to basic investigations (i.e. biochemistry, haematology, chest X-ray, ECG), lung function should be routinely tested before any thoracic surgery in order to detect pulmonary deficits. It is also important to assess the integrity of the cardiopulmonary system as a whole. Functional capacity can be assessed at the bedside using the Duke activity status index which estimates metabolic equivalents (METs), the patient’s metabolic rate at their reported maximum achievable physical activity. The ability to climb a flight of stairs is equivalent to 4 METs, the minimal requirement for major surgery. Another simple assessment is to measure the patient’s ability to maintain normal oxygen saturation during exercise.

Any deficits in these functional assessments indicate that more careful investigation, including cardiological and respiratory referral, is required. Further investigation may include treadmill exercise testing, echocardiographic stress testing, ambulatory ECG and thallium perfusion imaging. Pre-operative cardiopul-
monary exercise testing can determine anaerobic threshold and myocardial ischaemia. Mortality after major surgery correlates with an anaerobic threshold < 11 ml min\(^{-1}\) kg\(^{-1}\), particularly when myocardial ischaemia is also present. Nagamatsu and co-workers found that oesophagectomy patients with a maximum oxygen uptake of < 699 ml min\(^{-1}\) m\(^{-2}\) had a cardiopulmonary complication rate of 86% compared with 44% for those with a maximum oxygen uptake > 700 ml min\(^{-1}\) m\(^{-2}\).

**Pre-operative preparation**

Pre-operative preparation includes treatment of any intercurrent acute or unstable medical problems (e.g. aspiration pneumonia, metabolic or electrolyte abnormalities) all of which are common in association with dysphagia. Unstable coronary syndromes may require medical or interventional cardiology treatment. Delaying surgery for the treatment of nutritional deficiencies by feeding has not been shown to improve outcome. However, dietary advice should be given to patients with dysphagia and enteral or parenteral feeding considered for cachectic patients during their pre-operative work-up. Pre-operative optimisation of the circulation to increase cardiac output using fluid and inotrope infusions may improve outcome. Although this is an attractive concept, it requires pre-operative critical care support and should be used with caution in patients with either known myocardial ischaemia or with two or more cardiac risk factors. Peri-operative \(\beta\)-adrenoceptor blockade has been shown to reduce the incidence of adverse cardiac events in high cardiac risk patients in the postoperative period. Again, testing has been limited and at this time we would not advise starting \(\beta\)-adrenoceptor blockers before major surgery in those patients who do not have a medical indication such as hypertension or proven myocardial ischaemia.

**Operative and postoperative management**

**Operative monitoring**

The NCEPOD report that reviewed deaths after oesophagectomy identified the incidence of monitoring the following parameters: direct arterial blood pressure 94%; CVP 88%; urine output 94% and temperature 65%. These 4 parameters should be monitored routinely. However, because of the incidence of peri-operative cardiovascular instability, many anaesthetists think that some sort of monitor of cardiovascular performance (e.g. cardiac output) is appropriate in higher risk patients. Intermittent monitoring of blood gases, haemoglobin and serum potassium during the operation is also advised strongly.

**Management of the circulation**

During oesophagectomy, patients can lose a substantial amount of their circulating volume leading to a low cardiac output. Older patients have a tendency for poor postoperative urine output and, following one-lung ventilation, patients have increased interstitial lung water. Therefore, correct circulatory management is of paramount importance. Operative and early postoperative fluid therapy, and inotropic therapy if indicated, should ideally be directed by indices acquired from a pulmonary artery catheter or PiCCO (pulse contoured cardiac output), particularly in those with cardiovascular risk factors. In practice, a fluid challenge is probably the most reliable method to achieve optimal filling of the circulation. For this, 100–200 ml colloid is infused in < 10 min and the changes in CVP observed. If the CVP increases and remains > 7 mmHg above baseline, the circulating volume is adequate. If, after an initial increase, it then decreases to < 3 mmHg above baseline, the circulation is more likely to be under-filled and the fluid challenge should be repeated. Blood transfusion should be dependent on local protocol, bearing in mind the patient’s circulation and requirement for adequate oxygen delivery. Urine output should be maintained at > 0.5 ml kg\(^{-1}\) h\(^{-1}\) and fluid balance monitored postoperatively for at least 3 days or until the patient can maintain their own homeostasis.

**Respiratory management**

Whenever a double lumen tube is used, those who supervise it should be trained and experienced in its correct positioning and management. Hypoxaemia during one-lung ventilation is often due to malposition or migration of the tube and the anaesthetist should have a low threshold for reconfirming its position, including the use of fibre-optic examination, which may necessitate interrupting the operation. If available, pressure controlled ventilation (PCV) to keep plateau pressure < 35 cmH\(_2\)O during one-lung ventilation is preferred. If PCV is unavailable, the dependant lung should be ventilated with a tidal volume of 8–10 ml kg\(^{-1}\) at a rate that maintains normocarbia as closely as possible. Peak airway pressure should be minimised by adjusting the inspiratory/expiratory ratio. There is an increase in intrinsic lung PEEP during one-lung ventilation and, in order to attain the optimum functional residual capacity and minimise intrapulmonary shunting in the dependent lung, the applied PEEP should equal intrinsic PEEP. In order to achieve this, when volume-controlled ventilation is used, PEEP should be applied incrementally so that the peak airway pressure rises only minimally and, when pressure con-
trolled ventilation is used, PEEP should be applied to optimise lung compliance. Excessive PEEP results in a sharp increase in peak airway pressure and a decrease in cardiac output and oxygen delivery. In order to limit shunt in the non-dependent lung, CPAP can be applied, the level of which depends on the lung properties. For normal lungs, 5 cmH₂O is usually sufficient whereas emphysematous lungs distend more and may need as little as 2 cmH₂O. Postoperatively, the decision on when to extubate the trachea must be made individually based on the patient’s stability (respiratory and circulatory) and temperature (core and peripheral). In principle, the period of postoperative lung ventilation should be minimal as early tracheal extubation and mobilisation is beneficial. The high incidence of respiratory problems mandates intensive postoperative chest physiotherapy.

Pain relief

There is evidence that neuroaxial blockade reduces mortality and morbidity after major surgery and following oesophagectomy epidural analgesia, when compared with patient-controlled intravenous analgesia, provides superior pain relief. Of patients reviewed by NCEPOD, 74% received epidural analgesia, suggesting it is the analgesia of choice. However, epidural analgesia is not always practical. In practice, good pain control managed by a dedicated pain team allows early mobilisation and effective chest physiotherapy. This is more important than the specific type of pain relief.

Postoperative location and care

Patients need to be nursed postoperatively in an environment appropriate to their medical status and operative risk. The appropriate area depends on local staffing levels and monitoring equipment but, as a minimum, it should be level 2 (i.e. patients requiring more detailed observation or intervention, including support for a single failing organ system) until the patient is clinically stable. The hospital should also have the facility for full ICU care. Postoperative monitoring should include pulse oximetry for a minimum of 3 days and continued as long as clinically indicated. Cardiac dysrhythmia is common following oesophagectomy and tachydysrhythmia is associated with increased morbidity. Most rhythm disturbances start within the first 48–72 h postoperatively suggesting that continuous ECG monitoring should be maintained for at least the first 2–3 days, or until there is sustained normal cardiac rhythm.

Almost any complication following oesophagectomy can rapidly progress to multiple organ failure. Therefore, if medical problems supervene, there must be early involvement of a critical care physician with specific experience in managing oesophagectomy patients. Dysfunction of any organ requires early and active support. In particular, there should be a high index of suspicion for the presence of an anastomotic leak or the less common gastric necrosis. These are serious and often fatal complications, especially when the anastomosis is intrathoracic and the gastric pedicle is stretched. Anastomotic leak remains undiagnosed in 50% of cases, it may manifest at 3–7 days, often following an initial good recovery, by non-specific signs such as pyrexia, general malaise, respiratory infection or cardiac arrhythmia so that early and frequent radiological studies to detect it are indicated. Many centres now practice an early intervention approach to respiratory complications, supplementing physiotherapy with repeat toilet bronchoscopy, mini or full trachectomy and respiratory support.

Postoperative feeding

Oesophagectomy patients require early postoperative feeding. The choice between enteral or parenteral feeding is a decision based on local experience. Enteral feeding can be achieved using a jejunal tube inserted percutaneously at the time of the oesophagectomy, so bypassing the stomach and its anastomosis. However, if ileus is prolonged or the jejunal tube is displaced, there should be early introduction of parenteral feeding.

Key references


See multiple choice questions 64–68.