Key points
Mediastinoscopy is a common procedure performed for the diagnosis of thoracic disease and staging of lung cancer. Systemic manifestations of bronchogenic cancer may have significant implications for the anaesthetist. Patients with a mediastinal mass may present specific problems because of compression of vital structures. Major haemorrhage is a rare but potentially fatal complication of mediastinoscopy.

Mediastinoscopy
Mediastinoscopy is a diagnostic procedure, which was first described by Carlens in 1959. Despite the availability of sophisticated imaging techniques (e.g. positron emission tomography), mediastinoscopy remains essential in the staging of lung cancer because of its high sensitivity (>80%) and specificity (100%). Other indications for mediastinoscopy include biopsy of mediastinal masses especially where other investigations, for example CT-guided biopsy have been inconclusive and establishing a diagnosis in diseases presenting with mediastinal lymphadenopathy (e.g. sarcoidosis, lymphoma).

Anatomy
The mediastinum is the region between the two pleural cavities extending from the thoracic inlet to the diaphragm. It is divided into the superior and inferior mediastinum by the transverse thoracic plane, which is an imaginary plane extending horizontally from the sternal angle anteriorly to the inferior border of the T4 vertebra posteriorly. The inferior mediastinum is subdivided into anterior, middle, and posterior compartments by the heart and pericardium (Fig. 1). This classification is used for describing the origin and spread of tumours (i.e. anterior to, adjacent to, or behind the heart and pericardium) and it should be noted that there are no anatomical or fascial planes separating the different compartments. The mediastinum is rich in lymph nodes that are the site of localized inflammatory disease, primary lymphatic tumours or metastatic disease. Table 1 gives a list of conditions which may present as a mediastinal mass.

Preoperative considerations
Bronchogenic carcinoma
Most patients with lung cancer are smokers with significant co-existing morbidity including hypertension, coronary artery disease, peripheral vascular disease, and pulmonary disease.

Mediastinal mass
Patients with a large mediastinal mass present a difficult challenge for the anaesthetist because of compression of adjacent vital structures. The severity of symptoms produced depends on the size and location of the mass, the rate of growth, and the invasion of adjacent vital structures. However, the majority of these patients are asymptomatic and the mass is discovered on routine chest X-ray.

Mediastinoscopy
The majority of mediastinoscopies are performed via the cervical approach, entering the mediastinum through a 3-cm incision in the suprasternal notch. A dissection is made between the left innominate vein and the sternum creating a tunnel in the fascial layers. The mediastinoscope is then inserted anterior to the aortic arch. The less commonly performed anterior approach is through the second intercostal space, lateral to the sternal border; this is used to inspect the lower mediastinum.

Contraindications
Previous mediastinoscopy is a relatively strong contraindication to a repeat procedure because scar tissue eliminates the plane of dissection. Superior vena cava (SVC) syndrome increases the risk of bleeding from distended veins and is a relative contraindication. Other relative contraindications include severe tracheal deviation, cerebrovascular disease, severe cervical spine disease with limited neck extension, previous chest radiotherapy, and thoracic aortic aneurysm.

Tracheobronchial compression
Tracheobronchial compression leads to persistent respiratory tract infection, unilateral wheeze, or stridor. Difficulty with ventilation and cardiac arrest in the course of anaesthesia for diagnostic or therapeutic procedures in
patients with mediastinal mass is well described.\(^3,4\) However, defining the actual incidence of these complications is difficult. Some centres have reported an incidence in paediatric patients of 7–20% during anaesthesia and 18% in the postoperative period. The incidence in adults is believed to be much less,\(^5\) because the narrow compliant airways in children are more susceptible to obstruction.

Tracheobronchial obstruction can potentially worsen with induction of general anaesthesia and intermittent positive pressure ventilation (IPPV). Decreased chest wall tone and cephalic displacement of the diaphragm leads to loss of the distending transmural pressure gradient. Hence, maintenance of spontaneous ventilation is critical to avoid precipitating complete obstruction in these patients. Awake intubation or inhalational induction with maintenance of spontaneous ventilation is recommended depending on the degree of obstruction and the symptoms produced. If there is any difficulty in ventilation because of obstruction at the level of the carina or the bronchus, a rigid bronchoscope should be inserted and ventilation maintained by connecting a Sanders injector or jet ventilator to the side port of the bronchoscope. In the presence of severe symptomatic obstruction, stenting could be performed prior to mediastinoscopy.

SVC syndrome

Compression of the SVC by enlarged lymph nodes or a mediastinal mass can result in obstruction of blood flow from head, neck, and upper extremities, resulting in SVC syndrome.\(^6\) The clinical manifestations depend on the rapidity of growth of the tumour and development of collateral circulation. Impaired venous drainage causes tongue swelling and laryngeal oedema making intubation potentially difficult. Patients with extensive orofacial swelling, hoarseness, and distension of the azygous vein on CT scan are at increased risk of bleeding from relatively minor trauma at intubation. Head elevation, steroids, and diuretics may help in improving symptoms before surgery.

Systemic effects

Lung or mediastinal tumours cause extra-thoracic symptoms by metastatic spread or by the secretion of endocrine hormones or hormone-like substances, for example ACTH, ADH, PTH. Table 2 gives a list of the paraneoplastic syndromes associated with lung cancer, which have anaesthetic implications.
Thymic tumours are associated with myasthenia gravis that causes weakness and fatigability of voluntary muscles. Clinical manifestations range from isolated ocular symptoms to respiratory muscle involvement. Patients with myasthenia gravis are sensitive to non-depolarizing muscle relaxants and have a variable response to depolarizing agents. Eaton–Lambert syndrome (myasthenic syndrome) is proximal myopathy associated with small cell carcinoma. Reduction in acetylcholine released from presynaptic motor nerve terminals in these patients causes increased sensitivity to all neuromuscular blocking drugs. In contrast to myasthenia gravis, the muscle weakness improves with exercise and is not reversed by acetyl cholinesterase inhibitor therapy.

Investigations

In addition to routine haematology, biochemistry, and ECG, preoperative investigations should include chest X-ray, and CT scan aimed at evaluating the location of the tumour, its relation to adjoining structures, and the degree of tracheal compression. Pulmonary function tests are useful in detecting the severity of pre-existing lung disease and effects of mediastinal mass. Flow–volume curves should be obtained in the upright and supine position to evaluate functional impairment and ascertain the presence of obstruction. Both inspiratory and expiratory flows are usually reduced in the presence of an intrathoracic mass. A disproportionate decrease in maximal expiratory flow should raise suspicion of tracheomalacia.

Additional investigations (e.g. echocardiography and stress testing) may be indicated in the presence of cardiac symptoms. Factors that predict an increased risk of perioperative respiratory problems in patients with a mediastinal mass are cardiopulmonary signs and symptoms at presentation, a combined obstructive and restrictive picture, PEFR < 40%, and tracheal diameter < 50% on CT scan. However, in suitably selected patients, mediastinoscopy can be carried out as a day-case procedure.

Premedication

A short-acting benzodiazepine may be prescribed to decrease anxiety; however, sedative drugs should be avoided if tracheal obstruction is suspected.

Anaesthetic management

Large bore intravenous cannulae should be inserted and cross-matched blood should be available because of the potential risk of haemorrhage. If the patient is asymptomatic, preoxygenation followed by intravenous induction of anaesthesia can be performed. In the presence of respiratory obstruction, an awake intubation under local anaesthetic is the technique of choice. This allows the entire anaesthetic and surgical team to view the exact level of obstruction and the endotracheal tube is passed distal to obstruction. In case of a more distal obstruction (carinal level), a rigid bronchoscope should be available for low-frequency jet ventilation. Alternatively, an inhalation induction may be used, followed by intubation of the trachea under deep anaesthesia.

The patient is placed in a 20° head-up position to reduce venous congestion; however, it should be remembered that this position increases the chances of air embolism. Surgical access is improved by resting the shoulders on a sandbag and the head on a head ring.

An intravenous anaesthetic agent, inhalational anaesthetic agent, or both, together with a neuromuscular blocking agent and a bolus or continuous infusion of a short-acting opioid will allow an adequate level of anaesthesia and rapid postoperative recovery. Ventilation of both lungs through a single-lumen endotracheal tube is usually adequate. A reinforced tube is preferred to minimize the risk of the tube kinking during surgery. With a long-standing mass, fibreoptic endoscopy should be performed prior to extubation to rule out tracheomalacia.

Ideally, muscle relaxants should be avoided in patients with clinical features suggestive of myasthenic syndrome. If used, doses should be carefully titrated to response as measured by neuromuscular monitoring. Patients should only be extubated after full recovery of reflexes and neuromuscular function; a short period of postoperative ventilation may be required.

Local anaesthetic infiltration of the wound, superficial cervical plexus and intercostal nerve blocks aid postoperative analgesia. Regular paracetamol and NSAIDs (if not contraindicated) could be prescribed as part of multimodal analgesia. Postoperatively, a chest X-ray should be taken in all patients in the recovery room to exclude pneumothorax. Subsequently, patients can be cared for on the ward; they should be observed specifically for dyspnoea and stridor, which may be caused by injury to the recurrent laryngeal nerve or a paratracheal haematoma.

Monitoring

Invasive arterial blood pressure monitoring is preferred for the early detection of reflex arrhythmias and compression of major vessels with mediastinoscope. This should preferably be sited in the right arm for detection of brachiocephalic compression, which results in reduction in blood flow to the right carotid artery and may cause ischaemia in the presence of inadequate collateral circulation. Alternatively, the pulse oximeter probe should be placed on the right hand. Neuroromuscular monitoring is mandatory in patients with myasthenia gravis and Eaton–Lambert syndrome. The ventilator pressure gauge should also be observed to note any acute increase in airway pressure, which indicates tracheal or bronchial compression by the mediastinoscope. The use of pressure-controlled ventilation helps in the early detection of a rise in airway pressure.

Management of complications

The potential complications associated with mediastinoscopy are listed in Table 3.
Vessel damage

The incidence of major haemorrhage after mediastinoscopy (defined as persistent bleeding that requires exploration through a median sternotomy or thoracotomy) is ~0.4%,9 but is increased in the presence of aberrant vessels, mediastinal inflammation, and SVC obstruction. The most frequently injured vessels are the azygos vein, the innominate vein, and the pulmonary arteries. Initial control of bleeding is attempted with compression and packing of the wound. If this fails to control bleeding or there is persistent haemodynamic instability despite volume resuscitation, surgical exploration is indicated. Innominate vein and pulmonary artery injuries can be repaired through a midline sternotomy, whereas azygos vein injuries require right posterolateral thoracotomy.

The basic principles of management are the same as that of any major haemorrhage, but there are some features unique to mediastinal haemorrhage. Large bore venous access should immediately be secured in the lower limbs, as the bleeding could be from venous disruption of vessels draining into the SVC. Some authors recommend routine venous access in the lower limbs for all patients undergoing mediastinoscopy. This may not be justified considering the rarity of major haemorrhage.9 Lung isolation is not essential for midline sternotomy; however, if thoracotomy is planned, selective lung collapse may be needed. If the initial intubation was not difficult, this can be achieved by passing a left-sided double lumen tube while the bleeding is being controlled by digital compression. In case of difficult intubation or life-threatening haemorrhage, where the anaesthetist is preoccupied in resuscitation of the patient, deliberate endobronchial intubation with a single lumen tube could be performed. Alternatively a bronchial blocker may be used, but accurate placement requires a fibreoptic bronchoscope and more time is required to collapse the lung.

Injury of the aortic arch and supra-aortic arteries is rare. These lead to neck haematoma and tracheal distortion making reintubation difficult, even if the initial intubation was easy. Minor bleeding usually results from injury of the vessels supplying the lymph nodes; this responds to compression and packing.

Lung damage

The reported incidence of pneumothorax after mediastinoscopy is 0.08–0.23%. Tube thoracostomy should be performed at the end of the surgery if there is a known pleural tear with trauma of the lung tissue. An asymptomatic patient with a small pneumothorax (<20%) detected on postoperative chest X-ray can simply be observed.

Other complications

Other possible complications include stroke (brachiocephalic artery compression), tracheobronchial injury, and phrenic and recurrent laryngeal nerve injury (Table 3).

Future developments

Video-assisted mediastinoscopy (VAM) is increasingly being used in most centres. The increased visual field, image magnification, and ability to use two instruments simultaneously make it a popular technique. Video-assisted mediastinal lymphadenectomy and lobectomy (VAMLA and VATS-Lobectomy) are emerging as popular techniques for the excision of lung cancer. These require selective lung collapse. However, there is an increased incidence of complications because of inappropriate biopsy or vessel injury as surgeons rely more on visual cues than the traditional techniques of palpation and finger dissection.

References


Please see multiple choice questions 4–7