Surgical approach to lung cancer resection

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Thoracotomy Although the most frequent indication for thoracotomy is lung cancer, all surgeons dealing with trauma should be able to perform a thoracotomy if required. The standard route into the thoracic cavity is through a posterolateral thoracotomy . The incision is used for access to the: /uni25CF lung and major bronchi; /uni25CF pleura; /uni25CF thoracic aorta; /uni25CF oesophagus; /uni25CF posterior mediastinum. A double-lumen endotracheal tube is used to allow ven - tilation of one lung while the other is collapsed, to facilitate surgery and to protect the non-operated lung and retain con - trol of ventilation (Figure 60.16). The patient is turned to the - -

Tracheal in /f_l atable cuff Bronchial in /f_l atable cuff Figure 60.16 The double-lumen tube permits separate ventilation of the right and left lungs.

lateral position with the a ff ected side up (Figure 60.17 incision passes 1–2 /uni00A0 cm below the tip of the scapula and extends posteriorly and superiorly between the medial border of the scapula and the spine. /uni25CF The incision is deepened through the subcutaneous tissues to the latissimus dorsi. This muscle is divided with coagu lating diathermy , taking care over haemostasis. /uni25CF A plane of dissection is developed manually , deep to the scapula and serratus anterior. The ribs can be counted down from the highest palpable rib (which is usually the second) and the sixth rib periosteum is scored with the dia thermy near its upper border. A periosteal elevator is used to lift the periosteum o ff the superior border of the rib or, alternatively , the intercostal muscle is cut with diathermy just above the rib (Figure 60.18). /uni25CF This reveals the pleura, which may be entered by blunt dissection. A rib spreader is inserted between the ribs and opened gently to prevent fracture. In an emergency thoracotomy for penetrating wounds of the heart, a more anterior approach is used and no specialised supporting equipment is required (Figure 60.19). The incision is taken down to the fourth or fifth rib with a scalpel, and the pleural cavity is opened using scissors. This gives rapid access to the left pleural cavity in cases of massive left haemothorax and the pericardium if cardiac tamponade is suspected. A left anterior thoracotomy can be quickly converted to a clamshell or bilateral thoracotomy if necessary . Analgesia is an important aspect of postoperative care, and the process may be started prior to thoracotomy with an epi dural catheter placed by the anaesthetist or intraoperatively by infiltrating the intercostal nerves in the region of the incision with a long-acting local anaesthetic or increasingly via a surgi-). The cally sited paravertebral catheter. Various strategies have been developed to deliver analgesics postoperatively to facilitate a normal breathing pattern. Video-assisted thoracoscopic surgery (VATS) Various approaches utilising thoracoscopic techniques can - be used to gain access to the chest cavity and facilitate lung - -

Double-lumen tube to protect the underlying lung Elbows are placed at 90° to upper arms Incision curves below angle of scapula Underlying leg bent for stability Upper leg cushioned Figure 60.17 Correct positioning for thoracotomy. B 5 C 6 A 7 Latissimus dorsi 8 9 muscle Serratus anterior muscle Figure 60.18 Incision and layers encountered during posterolateral thoracotomy. A, The latissimus dorsi is divided in line with the skin incision. B, If the serratus anterior is divided, it should be close to its attachment to ribs 6, 7 and 8. It can be left intact and mobilised along its inferior border. C, The intercostal muscles are stripped off the upper border of the rib. A sandbag or dense pillow to roll the patient 30º Arm for anaesthetist' s Incision in 5th access intercostal space Arm back Figure 60.19 Emergency left anterior thoracotomy for access to the heart. This requires no special supports or devices.

lung resections with dissection of the hilar structures and full lymph node staging commonly performed through one- (uniportal), two- or three-port V ATS incisions. The technique avoids rib-spreading and appears to reduce postoperative pain and length of stay and aids a speedier recovery , particularly in frail patients. Robotically assisted thoracic surgery (RATS) In this approach, the thoracoscopy is done using a robotic system with three-dimensional vision. The surgeon sits at a control panel in the operating room and moves robotic arms to operate through several small incisions in the patient's chest. RATS is similar to V ATS in terms of less pain, less blood loss and a shorter recovery time (Figure 60.20). For the surgeon, the robotic system may provide more manoeuvrability and more precision when moving the instru ments than standard V ATS. It may have advantages when performing more comple x lung resections such as segmentec tomies or mediastinal tumours (thymectomy). Surgical management of lung cancer The principle of surgery is to remove all cancer (the primary and the regional lymph nodes) but to conserve as much lung as possible. The selection of patients in terms of the stage of the lung cancer and fitness to undergo such surgery is paramount. Surgery with curative intent is o ff ered to patients with early stage lung cancer (T1–3, N0–1) (Table 60.6). Assessment of a patient's fitness to undergo lung cancer resection involves considering premorbid conditions, which can be aided using risk scores such as Thoracoscore, cardiovascular function and lung function; see BTS guidelines in Assessment of fitness for major thoracic surgery and UK National Institute for Health and Care Excellence (NICE) guidelines in Table 60.7 Lung function, in particular, will aid the surgeon in selecting the type of procedure o ff ered and the likelihood of breathless ness or dyspnoea following lung resection. - Choice of lung resection Segmentectomy and wedge resection - Segmentectomy and wedge resections are performed in patients with small tumours (1–2 /uni00A0 cm) that are predominantly ground glass, not solid (lepidic) and with borderline fitness, through thoracotomy or increasingly by V ATS or RATS. Each lobe of the lung has segments, which allows anatomical dissection and ligation of the segmental pulmonary artery , vein and bronchus (segmentectomy) (Figure 60.2) or non-anatomical excision can be performed (wedge resection) combined with removal of regional lymph nodes. Lobectomy Lobectomy remains the treatment of choice for patients with early-stage lung cancer. The surgery can be performed via thoracotomy or V ATS. Following dissection of the fissure and hilar structures, the branches of the pulmonary artery and . veins to the lobe are isolated and ligated. The bronchus is usually stapled but can be sewn. - The patient does not routinely need intensive care and postoperative ventilation is best avoided. The 30-day mortal - ity rate is 1–2%, with morbidity such as chest infection or car - diac arrhythmia at around 10%. The average length of stay is around 5–7 days. Pneumonectomy Pneumonectomy is removal of a whole lung and has a higher mortality rate (5–8%). As such the number of pneumonec - tomies performed in the UK has fallen and now makes up less than 5% of lung cancer

surgery . The surgeon must be satisfied that the patient is fit to tolerate this procedure from the preoperative work-up. This procedure is reserved for either centrally placed tumours involving the main bronchus or those that straddle the fissure. Bronchoplastic lung resections Increasingly , owing to the associated complications and higher mortality of a pneumonectomy , preservation of lung tissue is being considered but without compromise of the surgical resection margins. Sleeve lung resections involve removing a central tumour that is invading a major bronchus, such as the LMB or RMB, together with the lobe of the lung involved,

TABLE 60.6 UK National Institute for Health and Care Excellence (NICE) recommendations for surgery for non- small cell lung cancer (NSCLC). Surgery with curative intent for NSCLC Offer patients with NSCLC who are /f_i t for surgery open or thoracoscopic lobectomy as the treatment of /f_i rst choice. If complete resection is possible, consider segmentectomy or wedge resection for patients with smaller tumours (T1a–b, N0, M0) and borderline /f_i tness Offer more extensive surgery (bronchoangioplastic surgery, bilobectomy, pneumonectomy) only when needed to obtain clear margins Perform hilar and mediastinal lymph node sampling or en bloc resection for all patients undergoing surgery with curative intent For T3 NSCLC with chest wall involvement, aim for complete resection by extrapleural or en bloc chest wall resection For people with operable stage IIIA–N2 NSCLC who can have surgery and are well enough for multimodality therapy, consider chemoradiotherapy with surgery Figure 60.20 A thoracic surgeon performing robotically assisted thoracic (RATS) lung resection remotely from an operating console.

with reanastomosis of the cut major bronchus to the remaining lobar bronchus. Complications of lung resection /uni25CF Bleeding . Bleeding should be avoidable by the use of a careful surgical technique but may be severe in the pres ence of dense adhesions. /uni25CF Respiratory infection . Many of these patients are ex-smokers and therefore basal collapse and hypoxaemia are common postoperatively . /uni25CF Persistent air leak . Chest drains are placed at the time of surgery to deal with the air leak. Rarely , the air leak persists and the remaining lung does not expand. Re-thoracotomy may then be necessary to seal the leak. /uni25CF Bronchopleural fistula . This is a serious complica tion. Following pneumonectomy , the space left behind is initially filled with air. This is slowly reabsorbed and the space fills with tissue fluid. The fluid level rises until the air is finally reabsorbed (Figure 60.21). Dehiscence of the bronchial stump leads to the development of a br oncho pleural fistula and the fluid in the space (which is almost inevitably infected) is expectorated in large quantities. This complication has a high morbidity and mortality rate. The patient is nursed sitting up and turned so that the a ff ected space is dependent; this is to pr event infected fluid from entering the remaining lung while arrangements are made to site a pleural drain. This should be connected to an underwater seal but not suction. Bronchopleural fistulae are unlikely to resolve spontaneously and management is highly specialised. Postoperative care Enhanced recovery after surgery (ERAS) is a strategy that seeks to reduce patients’ perioperative stress response, thereby reducing potential complications, decreasing hospital length of stay and enabling patients to return more quickly - to their baseline functional status. These principles have been applied to patients having lung cancer surgery . Postoperatively , patients have limited respiratory reserve following lung resec - tion, so infection and fluid overload are to be avoided. Once air leaks have settled, the drains are removed. Mobilisation, breathing exercises and regular physiotherapy are begun as soon as the patient’ s condition permits. Postoperative pain - It is important to deal with postsurgical pain e ff ectively so that a normal breathing pattern and gas exchange are achieved in the early postoperative period. Four strategies are routinely used in

combination: - 1 paravertebral/extrapleural or epidural catheter-delivered local anaesthetic; 2 intercostal nerve blocks; 3 PCA with intravenous boluses of opiates; 4 background oral analgesia with paracetamol and/or non-steroidal anti-inflammatory drugs. Long-term postsurgical pain can be reduced by careful attention to detail during the operation. Sources of avoidable chronic pain include rib fracture and the entrapment of inter - costal nerves during wound closure .

treatment with curative intent (including surgery). Perioperative mortality Consider global risk score, such as Thoracoscore Ensure patient is aware of risk before consenting Cardiovascular function Assess risk factors and cardiac functional capacity Avoid surgery within 30 days of MI Lung function Perform spirometry, measure TLCO if disproportionate breathlessness or other lung pathology, perform segment count and assess exercise tolerance Consider shuttle walk testing (cut-off 400 /uni00A0 m) and cardiopulmonary exercise testing (cut-off 15 /uni00A0 mL/kg/minute) if moderate to high risk of postoperative dyspnoea FEV , forced expiratory volume in 1 s; MI, myocardial infarction; TLCO, transfer factor for carbon monoxide. 1 From NICE Clinical Guideline 122, available from: www.nice.org.uk/guidance/ng122. Optimise primary cardiac treatment and begin secondary cardiac prophylaxis as soon as possible Offer surgery if two or fewer risk factors and good cardiac functional capacity Seek cardiology review if active cardiac condition, three or more risk factors or poor cardiac functional capacity Consider revascularisation before surgery in stable angina Continue anti-ischaemic treatment in perioperative period. Discuss perioperative platelet treatment if patient has a coronary stent Offer surgery if normal FEV and good exercise tolerance 1 or FEV or TLCO below 30% and patient accepts the 1 risks of dyspnoea Offer radiotherapy with curative intent if lung function poor but patient is otherwise suitable for radiotherapy with curative intent and volume of irradiated lung is small

For all malignancies, the lung is the most common site of metastases that often develop through haematogenous spread. The presence of metastases is regarded as a sign of advanced disease and few curative treatment options exist; however, surgical resection of lung metastases may result in a survival advantage, particularly with metastases from solid tumours such as colorectal cancer, though the evidence still remains uncertain. The selection criteria often used when considering lung metastasectomy include control of primary tumour; no evidence of metastases outside the lung; possibility of complete resection utilising lung-sparing techniques; and acceptable operative risks with adequate pulmonary function. Various approaches can be considered, though V ATS is increasingly favoured over thoracotomy owing to reduced postoperative pain and length of stay , and therefor e speedier recovery . The disadvantage of V ATS is the inability to palpate and evaluate the lung in its entirety to locate other nodules deeper within the lung parenchyma, particularly those not identified on prior CT imaging. The main principle when resecting lung metastases is to utilise lung-sparing techniques as much as possible, e.g. wedge resections rather than lobec - tomy , because it is likely that later reoperations to resect new metastases may be necessary . Long-term outcome depends on the primary tumour type, with germ cell tumours having the best outcome. Patients with epithelial tumours (carcinomas) generally hav e a 30–40% 5-year survival, as reported in several r etrospective series.

(b) (c) Figure 60.21 Chest radiographs (a) pre- and (b) post-pneumonec tomy, with rising /f_l uid level (c) in the left haemothorax.

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