Principles of posterolateral thoracotomy and pneumonectomy

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Abstract

Posterolateral thoracotomy is required to gain access to the thoracic cavity. The patient is placed on the operating table in a lateral decubitus position and a single-lung ventilation technique is used with a double-lumen endotracheal tube. The incision is made on the side of the chest towards the back between the ribs. Many thoracic surgical procedures can be performed by this approach including lung resections.

Pneumonectomy is a surgical procedure to remove whole lung and usually performed by posterolateral thoracotomy. It can also be performed by video-assisted thoracoscopic surgery (VATS). Pneumonectomy is indicated where curative surgical resection is not possible with lesser resection. Prior to pneumonectomy a thorough preoperative assessment of the patient is performed as per British Thoracic Society guidelines. This procedure leads to considerable reduction in respiratory reserve of the patient and is also associated with significant morbidity and mortality. Common complications include arrhythmias, myocardial infarction, pulmonary embolism, pneumonia, empyema, respiratory failure and bronchopleural fistula. The perioperative mortality rate ranges between 6% and 8%. Very dedicated and careful postoperative management is required in specialized centres to avoid complications.

Keywords Bronchopleural fistula; complications; lung cancer; lymph node sampling; pneumonectomy; postero-lateral thoracotomy

Posterolateral thoracotomy

The patient is placed on the operating table in a lateral decubitus position with appropriate pressure point padding. Soft rolls, bean bags, and strapping tape are used to secure the patient to the table. The lower leg is flexed at the hip and at the knee, while the upper leg is straight with pillows in between the legs. The table may be flexed to widen the intercostal spaces.

Before making an incision the inferior angle of the scapula, its medial and lateral borders are palpated and outlined. The position of the vertebral spines, iliac crest and the nipple is noted. The standard incision follows the course of the underlying ribs, beginning, in front of the anterior axillary line at the anterior border of the latissimus dorsi muscle and passes 3–4 cm below the scapula tip and extends posteriorly midway between the posterior midline over the vertebral bodies and the medial border of the scapula (Figure 1). The incision may be extended anteriorly and converted into a thoraco-abdominal incision to permit access to the abdomen. Posteriorly, the incision may be extended paraspinally to permit access to the upper rib spaces.

With the help of diathermy, the incision is deepened through the subcutaneous tissue and superficial fascia until the fasciae overlying the latissimus dorsi and trapezius muscle are exposed. The latissimus dorsi muscle is divided. The serratus anterior muscle may be retracted out of the way but is sometimes divided to provide anterior extension. The nerve supply to these muscles courses from the axilla downwards, therefore, the muscles should be divided as close to the inferior aspect of the incision as possible to preserve their function. Posteriorly, a small portion of the trapezius muscle or higher up the rhomboid muscles may be divided for additional exposure.

The classical postero-lateral thoracotomy is associated with significant trauma by muscle division. A muscle-sparing approach is possible by taking advantage of the auscultatory triangle. This relatively avascular landmark is bounded superiormedially by the trapezius, inferiorly by the latissimus dorsi and laterally by the medial border of the scapula. With careful and generous subcutaneous dissection, the superior border of the latissimus dorsi is freed from the underlying rhomboids in the upper part of the incision, and from the fatty triangle below. Anterior retraction is facilitated by transection of the thoracolumbar fascia giving the posterior insertion to the muscle.

Selection of the appropriate intercostal space can be guided by counting the ribs with the scapula retracted off the chest wall. The surgeon's hand is slipped deep to the scapula and gently

Figure 1 Skin incision for posterolateral thoracotomy.

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pushed upwards to the apex. The second rib is normally felt as a step. The fifth intercostal space is considered the approach of choice for pulmonary resection as it allows optimal access to pulmonary hilum.

The periosteum is dissected from the superior border of the rib using periosteal elevator (to avoid injury to intercostal neurovascular bundle) and the pleural cavity is entered. Before entering the pleural cavity, ventilation of the lung on the operated side is stopped. On occasion, if single-lung ventilation is not possible due to the patient's physiology, surgery may proceed with intermittent lung ventilation. Many surgeons advocate a short-segment rib resection to avoid uncontrolled rib fractures and improve exposure. This involves excising a 1–2-cm segment of rib at the costo-vertebral angle posteriorly. A self-retaining retractor such as Finichetto retractor is used to open up the intercostal space. The retractor should be widened gradually to allow soft tissue stretching and minimize the risk of rib fracture. The thoracolumbar fascia and paravertebral muscles can be preserved by elevation with blunt dissection and retracted to expose the underlying rib posteriorly. After the procedure is completed, a chest drain is usually placed to drain the pleural cavity. Drain(s) are usually removed when the drainage is less than 400 ml/24 hours and no air leak detected. Catheters may be placed in the extra-pleural space along the necks of the ribs to continuously deliver local anaesthetic around the intercostal nerves as part of the postoperative pain management. An epidural catheter can be used as a method of regional pain control but is becoming less popular.

Thoracotomy closure involves approximation of the intercostal space, reconstitution of all the fasciae and divided muscles. Failure to do so will cause limitation in postoperative chest wall and shoulder excursion. Care should be exercized not to over-approximate the ribs and prevent an override which is a significant cause of postoperative pain. Sutures are placed to encircle the bone along the length of the incision. Some surgeons believe this leads to pressure on the intercostal nerve which may cause post-thoracotomy neuralgic pain. Variation of this technique by placing sutures through the lower rib rather than around it, may avoid this problem. The two musculofascial layers and skin subcutaneous tissues may be closed with a continuous suture.

Overview of pneumonectomy

Pneumonectomy is the removal of the entire lung. It is performed when disease clearance is not possible with lesser resections. Currently, pneumonectomy accounts for around 10% of all lung resections.[1] The first successful one-stage pneumonectomy for cancer was performed by Evarts Graham in 1933.[2]

The development of pulmonary resection parallelled that of anaesthetic advancements. Single-lung ventilation using either a double-lumen endotracheal tube or a bronchial blocker has made pneumonectomy a technically routine procedure.

In surgical resection for lung cancer, the International Union Against Cancer (UICC) recommends that at least six lymph nodes from hilar and mediastinal stations should be removed or sampled to provide accurate nodal staging[3] (Figure 2). There is considerable variation in practice among surgeons from lymph node sampling to systemic nodal dissection.

Pneumonectomy carries significant morbidity and mortality. Poor outcome following pneumonectomy is related to several important risk factors. The procedure results in considerable loss of lung parenchyma with significant diminution of respiratory reserve. The UK perioperative mortality rate for pneumonectomy is 6–8%.[4,5] The incidence of complication (atrial arrhythmias, bronchial stump leaks, respiratory insufficiency) is higher than for lobectomy.

Anatomy of hilum of lungs

On the medial side of each lung, about two-thirds of the distance from its base to its apex, is the hilum, the point at which the bronchi, pulmonary arteries and veins, lymphatic vessels, and nerves enter the lung from the mediastinum. Anterior most structures leaving the lungs at the hilum are the pulmonary veins, lying behind the veins are the branches of the pulmonary artery entering the lungs through the hilum. Secondary/lobar bronchi are the most posterior structures, entering the substance of lungs at the hilum.

The pleura folds around the hilum of the lung and has an extension inferior to the hilum called the pulmonary ligament. This allows room for the pulmonary veins (and the low-pressure pulmonary arteries too) to dilate or expand whenever there is increased blood flow through them.

The left hilum is bounded anteriorly by the left phrenic nerve which courses more anteriorly then on the right. The left vagus nerve runs closer to the lung than its right-sided counterpart. The arch of aorta courses over the left hilum then descends behind it. The right hilum is bounded anteriorly by the right atrium, vena cava and by the phrenic nerve; it relates posteriorly to the azygos vein, oesophagus and vagus nerve. Superiorly it is bounded by the arch of azygos vein and the trachea-bronchial lymph nodes (Figure 3a and b).

Indications

In the developed world, the main indication for pneumonectomy is the treatment of lung cancer. Other indications include the removal of destroyed lung resulting from suppurative pulmonary conditions (such as *Mycobacterium* infection, bronchiectasis) and congenital abnormalities. The pneumonectomy rate in the UK has been falling due to advances in parenchymal sparing surgical techniques such as bronchoplastic and sleeve resections. In lung cancer surgery, parenchymal sparing is not always possible. Pneumonectomy is required for disease clearance such as when tumour invades multiple hilar structures or crosses a fissure. Oncological principles dictate that disease clearance should take precedent in cancer surgery. This may only be achievable by sacrificing the entire lung.

Operability and resectability are the two main considerations in preoperative assessment. The former refer to the fitness of the patient to undergo and recover from the procedure. Resectability is the evaluation of the possibility of complete surgical disease clearance.

Operability: fitness for surgery

Assessment of patients undergoing pneumonectomy as per British Thoracic Society (BTS) guidelines is summarized below.[6]

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