Thoracic Anesthesia Can Be a Pleasure!

Tips and Tricks For Maximizing Success

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Despite advances in diagnosis and treatment in many areas of oncology, lung cancer remains a deadly disease and is the major source of the increasing caseload of thoracic surgery procedures today. A steadily increasing proportion of these cases are diagnosed in women. Complete surgical excision of tumor remains the only hope of cure. With more cardiac procedures moving from the OR to the cardiac catheterization laboratory, many cardiac surgeons are returning for fellowships in the burgeoning field of minimally invasive thoracic surgery. Only about 14% of lung carcinomas are of the small cell type; the remainder are squamous or adenocarcinomas which are operable if diagnosed early.

Anesthesia for minimally invasive, video-assisted thoracic surgery (VATS) is similar to anesthesia for open thoracic cases in many respects. However, achieving lung isolation quickly and completely is even more important, since even a slightly inflated lung may obstruct the surgeon's view. Procedures that are amenable to VATS include:

- Mediastinoscopy
- Wedge resection or lung biopsy
- Lobectomy or segmentectomy
- Pleurodesis, mechanical or talc, for pleural effusion or spontaneous pneumothorax
- Decortication, including evacuation of empyema or hemothorax
- Lung volume reduction as treatment for severe emphysema.

Any patient may be a candidate regardless of extremes of age or pulmonary disease. Procedures still requiring open thoracotomy include pneumonectomy, tracheal resection, and chest wall resection. The advantages of VATS include decreased hospital length of stay, decreased morbidity, and the ability to do more cases per day in each OR.

The keys to anesthesia success include:

- Facility with placing both right and left endobronchial tubes;
- Skill with fiberoptic bronchoscopy and thoracic epidural anesthesia;
- Having a dedicated team of personnel who routinely handle these cases;
- Hospital investment in a high-quality video laryngoscopy system.

The video laryngoscope reduces the incidence of difficult airway problems and facilitates rapid, atraumatic tube placement. According to our usual routine, the anesthesiology team inserts the tube and then places the arterial catheter while the surgeon performs fiberoptic bronchoscopy. Once the patient is turned to the lateral position, we repeat fiberoptic bronchoscopy to optimize the position of the double-lumen tube (DLT).

Although the traditional teaching has been that a left DLT can be used for all cases, and that right DLTs are too difficult to place accurately, we disagree. There are several advantages to using opposite-sided DLTs routinely. These include:

- There is no risk of stapling the tube to the bronchus during lobectomy or pneumonectomy, which can lead to fatal complications;
- The surgeon has a complete view of the carina and mainstem bronchus on the operative side during bronchoscopy;
- There is no need to insert a single-lumen tube for bronchoscopy and then change to a DLT;
- If the tracheal cuff tears on the patient's molars, the bronchial cuff will still guarantee lung isolation;
- The tracheal lumen is always the one occluded during lung isolation, so it is easy to look down the tracheal lumen with a bronchoscope to check the position of the blue (bronchial) cuff without interrupting ventilation;
- With left lung surgery and a left DLT, the tracheal orifice may be pushed against the tracheal wall and occluded;
- With left lung surgery and a left DLT, pressure on the operated lung may dislodge the bronchial cuff and push it out into the trachea, losing lung isolation;
- Tubes that face downward, into the ventilated lung, are very stable.
- DLT is the only practical alternative for sleeve resection of the mainstem bronchus.
- It is very easy to insert right DLTs because the path to the right lung is more direct, and positioning is less of a challenge with today's fiberoptic bronchoscopes.

We do not find bronchial blockers of use during VATS because they do not allow the operative lung to deflate adequately.

In years past, a tidal volume (Vt) of 10 ml/kg was advocated for one-lung ventilation (OLV). However, lower tidal volumes of 5-6 ml/kg now are strongly preferred.[1,2] The mechanical forces of large Vt may produce shear stresses that damage alveoli, and alveolar overdistension causes damaging cellular activation and mediator release. Compression of blood vessels by high Vt leads to increased PVR, which in turn produces further proinflammatory effects. Schilling and colleagues studied patients on OLV who were randomized to Vt of either 5 or 10 ml/kg. Bronchoalveolar lavage demonstrated reduced levels of cell injury markers including alveolar TNF and slCAM-1 in the patients ventilated at lower Vt, along with stable levels of the anti-inflammatory IL-10.[3] Other recommendations for OLV include:

- Maintaining PAP less than 35 cm H_20;
- Maintaining plateau pressure less than 25 cm H_20;

- Using PEEP up to 5 cm except for COPD patients;
- Controlling respiratory rate to maintain normal $PaCO_2$ or mild hypercapnia.

Acute lung injury (ALI) remains a feared complication of lung resection, and carries a high mortality rate if it progresses to full ARDS. ALI is defined as acute hypoxemia accompanied by radiographic pulmonary infiltrates without a clearly identifiable cause, occurring in the first 72 hours post surgery. In 1984, Zeldin and colleagues identified three major causative factors in the development of post-pneumonectomy pulmonary edema: right-sided pneumonectomy, large perioperative fluid load, and high urine output.[4] At Memorial Sloan-Kettering, a retrospective review of more than 2000 lung resection cases revealed an overall ALI incidence of 2.5%. Mortality was 50% in the post-pneumonectomy patients, and 42% in the post-lobectomy patients. Review of causative factors once again showed perioperative fluid load (more than 3 liters in the first 24 hours) to be a significant risk factor, along with poor pulmonary function (decreased DLCO and FEV_1). [5,6] There are other potential risk factors as well: neoadjuvant chemotherapy, radiation therapy, and transfusion.

A number of drugs and disorders may damage lung tissue, causing interstitial pneumonitis that may progress into pulmonary fibrosis. The drugs include oxygen, bleomycin, cyclophosphamide, methotrexate, amiodarone, and crack cocaine. Amiodarone in particular has been implicated in acute lung injury in 10 to 17% of patients, with fatality in 10% of these.[7] Immune system and connective tissue disorders which may cause pulmonary damage include scleroderma, rheumatoid arthritis, systemic lupus, and the pulmonary-renal syndromes (Wegener's, Goodpasture's).

It stands to reason that lungs with damage prior to surgery may be at higher risk for ALI/ARDS. Licker and colleagues have put forward what they refer to as a "multiple-hit" theory of ALI, concluding that specific risk factors may not reach statistical significance, but may combine to place an individual patient at very high risk.[8,9] These include prior pulmonary disease, neoadjuvant chemotherapy and/or radiation therapy, injurious mechanical ventilation, transfusion, and hyperoxia.[10,11,12] In a low-risk patient, it appears to be safe to use 80-100% oxygen during OLV, and this is certainly the comfort zone for most anesthesiologists. However, in the high-risk patient who has had neoadjuvant chemotherapy, we decrease the FiO_2 incrementally to maintain oxygen saturation at no more than 90 to 92 percent..

The choice of anesthetic technique for thoracic surgery is a topic of frequent debate. Many anesthesiologists are convinced that total intravenous anesthesia is the best technique since inhaled agents may counteract the benefits of hypoxic pulmonary vasoconstriction (HPV). However, there are advantages to the newer inhaled agents such as desflurane, which has less adverse effect on HPV, is an effective bronchodilator, and facilitates deep extubation. Schilling and colleagues documented reduced concentrations of inflammatory biomarkers after desflurane anesthesia for OLV compared with propofol.[13]

Epidural analgesia after thoracic surgery is indicated for open thoracotomy, bilateral VATS procedures, and lung volume reduction. We do not believe that the risk of thoracic epidural catheter placement is warranted for unilateral VATS procedures. Thorough field block with

local anesthesia by the surgeons, ketorolac, IV acetaminophen, and low-dose opioids provide good analgesia for most patients. Some intriguing data suggests that anesthetic and analgesic techniques may play more of a role than has previously been thought in affecting rates of cancer metastasis; the definitive answer will await prospective controlled trials.[14-17]

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