SPECIAL ARTICLE

Risk factors for thoracic surgery

Muhammad Saqib, MBBS, MCPS, FCPS

Anesthesiologist, Combined Military Hospital Kohat Cantt (Pakistan)

Correspondence: Col Muhammad Saqib, Classified Anesthesiologist, Combined Military Hospital Kohat Cantt (Pakistan); Email: bandeshah65@yahoo.com

ABSTRACT

Thoracic anesthesia for non-cardiac surgery has become a subspecialty and has its own challenges of being proficient in new surgical techniques and equipment in the clinical practice. Risk factors for thoracic surgery numerous, and include generally poor health of the patient, obesity, smoking, alcohol abuse, tumors pressing airways or great vessels of chest and pneumonectomy. Intraoperatively requirements of lateral position, one lung anesthesia and expected hemorrhage are the main risk factors. Postoperatively, infection, hemorrhage, risk of pulmonary embolism, tension pneumothorax and blow out of stump may adversely affect the outcome. Good selection and preparation of patients for thoracic surgery is very important to avoid high morbidity and mortality. Main aim of a good thoracic anesthesia plan is to avoid hypoxia and cardiovascular morbidity in the perioperative period.

Key words: anesthesia; Anesthesia Department: Epidural Anesthesia; Thoracic surgery; Risk Factors; Risk Assessment; Intubation, Intratracheal; Thoracostomy

Citation: Saqib M. Risk factors for thoracic surgery. Anaesth Pain & Intensive Care. 2016;20 Suppl 1:S77-S80

Received: 8 August 2016; **Edited:** 11 September, 10 October 2016; **Accepted:** 10 September 2016.

INTRODUCTION

Anesthesia for thoracic surgery has always been a big challenge for the anesthesiologist. A very comprehensive knowledge of respiratory anatomy and physiology is required for good thoracic anesthesia, as well as to deal with the complications arising during its delivery. Increased incidence of lung cancer and respiratory infections due to heavy environmental pollution has increased the non-cardiac thoracic surgery manyfold. Thoracic anesthesia presents a unique set of physiologic problems: lateral decubitus position, open pneumothorax and need of one lung ventilation. These physiologic changes require careful attention of the anesthesiologist to avoid serious complications.[1]

PREOPERATIVE EVALUATION

Preoperative evaluation should focus on the extent and severity of pulmonary disease and cardiovascular involvement. In the history details about dyspnea, cough, characteristics of sputum, cigarette smoking, exercise tolerance, and alcohol abuse should be obtained. Physical examination is done to find out any cyanosis, clubbing, obesity, posture of the patient during breathing and auscultation of the chest for any wheeze, wet sounds or murmurs. Patients have an increased risk when they are unable to climb two flights of stairs. Surgery for pulmonary malignancies needs specific assessment, taking into account the 'four M's'-mass effects, metabolic effects, metastases and medications.[4]

Laboratory studies that need to be done before thoracic surgery are electrocardiography, chest radiography, arterial blood gases, pulmonary function tests (FEV_1, FEV_1/FVC), CT, PET scan, diffusing capacity for carbon monoxide, maximal oxygen consumption and maximal stair climbing. A vital capacity of 50% below predicted or below 2 L is an indication of increased risk.[5] The ratio of forced expiratory volume in one second to forced vital capacity (FEV_1/FVC) is useful in differentiating restrictive (normal ratio) from obstructive (low ratio) disease. A 15 % improvement in pulmonary function tests after bronchodilator therapy is an indication for continued preoperative therapy. A mass that is seen on computed tomography is more likely to be malignant if it also demonstrates enhanced glucose uptake on the positron emission

tomography scan. Echocardiography is very useful to assess the cardiac function.

PREOPERATIVE MANAGEMENT

Prophylactic digitalis is required especially in resection of pulmonary tissues. Preoperative treatment of several conditions decreases postoperative complications.

Cessation of smoking at least 48 hours before surgery decreases carboxyhemoglobin but improvement in ciliary function and decrease in sputum production requires 8-12 weeks. Treatment of hypovolemia and electrolyte imbalance facilitates removal of bronchial secretions. Bronchodilatation may be achieved with sympathomimetic drugs, steroids, cromolyn sodium and/or parasympatholytic drugs. Treat pulmonary infection with antibiotics according to the results of the sputum culture and sensitivity tests. Morbid obesity may present a risk for airway management, positioning, difficulty in clearing secretions and chances of respiratory failure in postoperative period. Particular attention is required to avoid hypoxia in the perioperative and postoperative periods. When epidural catheter is considered to be placed it should be placed before induction of anesthesia to offer patient cooperation and decrease the incidence of neurological complications. At least 2 large IV cannulae (14-16 g) are mandatory. Central venous catheter, blood warmer, rapid infusion device are desired if blood loss is anticipated.

PEROPERATIVE MANAGEMENT

Induction of anesthesia and placement of the double lumen tube (DLT) may be hazardous in a patient with a tumor pressing the airway or superior vena cava. Spontaneous breathing and awake induction may be required in some patients with difficult airway or bronchopleural fistula. Left sided DLT is advantageous as compared to right sided DLT because of risk of collapse of right upper lobe. Flexible fiberoptic bronchoscope is very helpful in correct placement of the DLT. Slinger et al suggested routine use of flexible bronchoscope for correct placement of DLT to avoid critical complications.[7] Avoiding high airway pressures while preventing hypoxemia during one lung anesthesia are very important to avert *acute lung injury* (ALI) in the postoperative period. Lateral position provides optimal access for most thoracic procedures. Unfortunately this position alters the normal ventilation /perfusion relationship (V/Q). These derangements are further accentuated by induction of anesthesia, muscle paralysis, opening the chest, surgical retraction and initiation of mechanical ventilation. Although perfusion continues to favor the lower lung, ventilation favors the upper lung. This mismatch markedly increases the risk of hypoxia. Also induction of general anesthesia decreases FRC and moves the lower lung (perfused) to a less compliant part of the compliance curve. Moreover, positive pressure ventilation favors the upper lung as it is more compliant. All these factors worsen V/Q mismatching and predispose to hypoxia. Due to open pneumothorax the lungs are kept expanded by the negative pleural pressure. When one side of the chest is opened the negative pleural pressure is lost and the lung is collapsed. Spontaneous ventilation with open pneumothorax in the lateral position results in paradoxical respiration and mediastinal shift. These two effects can cause progressive hypoxia and hypercapnia, but fortunately these can be overcome by the use of positive pressure ventilation. Intentional collapse of the lung on the operative side greatly facilitates most thoracic procedures but complicates anesthetic management. The collapsed lung continues to be perfused but is no longer ventilated. So the patient develops right to left intrapulmonary shunt and associated hypoxia. Mixing of oxygenated blood from the ventilated lung and unoxygenated blood from the collapsed lung widens alveolar to arterial gradient hypoxia. But fortunately the blood flow to the non-ventilated lung is decreased by hypoxic pulmonary vasoconstriction and surgical compression of the upper lung.

Techniques for one lung ventilation are use of double lumen endobronchial tube, single lumen endotracheal tube plus bronchial blocker and single lumen endobronchial tube. Double lumen endobronchial tube is often used for one lung anesthesia. Patient related indications for one lung ventilation are confining infection or bleeding to one lung and for separate lung ventilation for large cyst or bulla, bronchopleural fistula and tracheobronchial disruption. Procedure related indications are pneumonectomy, lobectomy, segmental resection, thoracoscopy, anterior approach to thoracic spine, esophageal surgery and bronchoalveolar lavage. The principle advantages of DLTs are relative ease of placement, the ability of ventilating, either one or both lungs, and the ability to suction either lung. Robert Shaw, Carlens and White DLTs are available. Carlens is for left side and White is for right side and these have carinal hooks. Most commonly used Robert Shaw DLTs are

for both right and left sides and these are without carinal hooks. Placement of DLT is done with a curved blade laryngoscope. The DLT is passed with the distal curvature anterior after the tip enters the larynx, the tube is rotated 90 degrees to the side to be intubated. The tube is advanced till resistance is felt, the average length is about 29 cm at the teeth. The tube position is established using a preset protocol and confirmed by flexible fiberoptic bronchoscopy.[7]

Protocol for left sided DLT placement is that; inflate the tracheal cuff (5-10 ml) and check for bilateral breath sounds. Unilateral sounds indicate that the tube is too far, the tracheal lumen is endobronchial (withdraw the tube little up).Then inflate the bronchial cuff (1-2 ml) and clamp the tracheal lumen and check for left sided breath sounds. In case of persistence right sided breath sounds advance the tube. If there are unilateral right sided breath sounds, it is due to incorrect entry into right bronchus. Then selectively clamp each lumen and confirm one-lung ventilation. After clamping of tracheal lumen tidal volume is usually set to 10 ml/kg and the respiratory rate is increased by 20% to maintain minute volume and PCO_2. Complications of DLT are hypoxia due to tube malplacement or occlusion, traumatic laryngitis and tracheobronchial rupture due to overinflation of the bronchial cuff. Besides routine monitors (ECG, $EtCO_2$, SpO_2, NIBP), direct arterial monitoring is indicated in patients with poor cardiac or respiratory reserve and in resection of large tumors. Serial arterial blood gases are very useful to confirm the adequacy of ventilation and oxygenation. During thoracotomy, a radial artery catheter is placed in the dependent arm to aid in stabilizing the catheter. Central venous pressure monitoring is highly advisable and it reflects the net effect of venous capacitance, blood volume, and right ventricular function. Pulmonary artery catheter and transesophageal echocardiography are indicated in left ventricle dysfunction. Premedication with a parasympatholytic agent is useful in drying airway secretions but avoid narcotics and benzodiazepines in labile patients. Induction and maintenance of anesthesia may be done with IV propofol, ketamine, succinylcholine, opioids, benzodiazepines, lignocaine and non-depolarizing muscle relaxants.

Zeldin et al pointed out factors leading to postpneumonectomy pulmonary edema in the postoperative period in their retrospective study.[2] Licker et al found out 3% incidence of ALI in postpneumonectomy cases and pointed out four factors responsible for it : excessive intravascular volume, pneumonectomy, high intraoperative ventilatory pressures, and preoperative alcohol abuse.[3] Considering these studies we need a very close monitoring of the ventilatory pressures to avoid damage to the ventilated dependent lung. Cardiovascular stability is to be maintained while avoiding intravascular overload. A central venous and intra-arterial line may be very helpful in monitoring the cardiovascular system. Colloids and blood products may be preferred over crystalloids to replace the ongoing losses. Nitrous oxide is not used in thoracic anesthesia to avoid expansion of closed space lesions like bullae and pneumothorax. But prolonged use of 100% oxygen may cause damage to the lung. A mixture of oxygen and medical air may be used to avoid this complication in cases requiring prolonged anesthesia. All the current anesthetic techniques have been used successfully for thoracic surgery but the combination of a potent halogenated agent and opioid is usually preferred.

The greatest risk of one lung ventilation is hypoxemia. To reduce this risk, the period of one lung and use 100% O_2 ventilation may be kept to minimum. Hypoxemia during one lung ventilation may require one or more of the following measures: Periodic inflation of the collapsed lung,[2] CPAP 5-10 cmH_2O to the collapsed lung and early ligation of the ipsilateral pulmonary artery in pneumonectomy. Other measures like 5- 10 cmH_2O PEEP to the ventilated lung, changing the tidal volume and the respiratory rate and continuous insufflation of O_2 to the collapsed lung may improve hypoxemia. If hypoxia persists, immediately reexpand the collapsed lung and verify position of the tube. The ETT is suctioned to exclude excessive secretions or obstruction. Pneumothorax on the dependent ventilated side should be excluded.

POSTOPERATIVE MANAGEMENT

In the postoperative period most patients are extubated early to reduce the risk of pulmonary barotrauma, blowout of the bronchial stump and pulmonary infection. DLT is exchanged with regular tube. Patients are kept in PACU or ICU overnight at least. Ventilatory support may be required for fragile patients. Pain management in the postoperative period includes systemic opioids, patient controlled analgesia, NSAIDs, epidural analgesia, intercostal nerve blocks, intrapleural analgesia and cryoanalgesia. Other routine postoperative care includes semi-sitting position, supplemental O_2 and

close hemodynamic monitoring. Other procedures like mediastinoscopy, thoracoscopy, removal of mediastinal mass, esophageal and spine surgery require close monitoring and comprehensive postoperative care for successful outcome. Use of new surgical techniques like Harmonic scalpel and video–assisted thoracoscopic surgery has improved the outcome of thoracic surgery. Further, high skills are required in fiberoptic bronchoscopy and invasive cardiovascular monitoring to improve the anesthetic care of thoracic surgery patients.[6]

Conflict of interest: None declared by the author.

Author contribution: The author contributed in the literature search, data analysis and manuscript preparation, and accepts full responsibility for the material presented.

REFERENCES

1. Raiten JM, Blank RS. Anesthetic Management of Post-Thoracotomy Complications. Principles and Practice of Anesthesia for Thoracic Surgery: Springer; 2011. p. 601-8.
2. Zeldin RA, Normandin D, Landtwing D, Peters RM. Postpneumonectomy pulmonary edema. J Thorac Cardiovasc Surg. 1984;87(3):359-65. [PubMed]
3. Licker M, de Perrot M, Spiliopoulos A, Robert J, Diaper J, Chevalley C, et al. Risk factors for acute lung injury after thoracic surgery for lung cancer. Anesth Analg. 2003;97(6):1558-65. [PubMed] [Free full text] doi: 10.1213/01.ANE.0000087799.85495.8A
4. Slinger P, Darling G. Preanesthetic assessment for thoracic surgery. Principles and Practice of Anesthesia for Thoracic Surgery: Springer; 2011. p. 11-34.
5. Naithani U, Bajaj P, Bhatnagar N, Prasad CN. One year prospective analysis of morbidity and mortality associated with thoracic surgery. Anaesth Pain & Intensive Care. 2011;15(2):86-92. [Free full text]
6. Campos JH. Update on tracheobronchial anatomy and flexible fiberoptic bronchoscopy in thoracic anesthesia. Curr Opin Anaesthesiol. 2009;22(1):4-10. [PubMed] doi: 10.1097/ACO.0b013e32831a43ab.
7. Slinger PD. Fiberoptic bronchoscopic positioning of double-lumen tubes. J Cardiothorac Anesth. 1989;3(4):486-96. [PubMed]

★★★★★