# Anesthesia for video-assisted thoracoscopy

**Essay**
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*Osama Saleh Omar*

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# ABBREVIATIONS

| | |
|---|---|
| **ABG** | **Arterial blood gas** |
| **ASA** | **American Society of Anesthesiologist** |
| **ATP** | **Adenosine triphosphate** |
| **CAMP** | **Cyclic adenosine monophosphate** |
| **COPD** | **Chronic obstructive pulmonary disease** |
| **CPAP** | **Continuous positive airway pressure** |
| **CSF** | **Cerebro spinal fluid** |
| **CVP** | **Central venous pressure** |
| **DLT** | **Double lumen endotracheal tube** |
| **$ETCO_2$** | **End tidal carbon dioxide** |
| **FET** | **Forced expiratory technique** |
| **$FEV_1$** | **Forced expiratory volume in one second** |
| **$FIO_2$** | **Inspired oxygen fraction** |
| **FVC** | **Forced vital capacity** |
| **HPV** | **Hypoxic pulmonary vasoconstriction** |
| **KPa** | **Kilo Pascal** |
| **MAC** | **Minimum alveolar concentration** |
| **OLV** | **One lung ventilation** |
| **PA** | **Pulmonary artery or Alveolar Pressure** |
| **PAB** | **Pressure of abdominal content** |
| **$PAO_2$** | **Alveolar oxygen tension** |
| **$PaO_2$** | **Arteriolar partial pressure of oxygen** |

| | |
|---|---|
| **$PCO_2$** | **Carbon dioxide tension** |
| **PEEP** | **Positive end-expiratory pressure** |
| **PET** | **Positron emission tomography** |
| **$PETCO_2$** | **End tidal $co_2$ tension** |
| **PFR** | **Postoperative peak flow rate** |
| **PPO** | **Predicted postoperative** |
| **PpV** | **Pulmonary venous pressure** |
| **PVR** | **Pulmonary vascular resistance** |
| $\dot{Q}S$ | **Venous admixture** |
| $\dot{Q}\,SP$ | **Physiologic shunt** |
| **QT** | **Total cardiac output** |
| **RV** | **Right ventricle or Residual volume** |
| **$SPO_2$** | **Oxygen saturation pressure** |
| **$SVO_2$** | **Mixed venous oxygen saturation** |
| **TLC** | **Total lung capacity** |
| **TLV** | **Two lung ventilation** |
| **VATS** | **Video assisted thoracoscopy** |
| VA/Q | **Ventilation – perfusion ratio** |
| **VT** | **Tidal volume** |
| **ZEEP** | **Zero end expiratory pressure** |

# INTRODUCTION

**Definition :**

Video-assisted thoracic surgery (VATS) involves the performance of any thoracic procedure through small thoracic incisions 2cm to 4 cm using trocars, a thoracoscope and a video monitor ***(Shi-ping Luh et al., 2006)***.

**Advantages of endoscopic surgery:**

Compared with open thoracotomy, video-assisted thoracoscopic surgery is considered to be :

1- Minimally invasive .
2- Less postoperative pain.
3- Earlier mobilization.
4- Lower overall morbidity.
5- A shortened hospital stay.
6- Reduced costs.
7- A cosmetic incision.
8- A reduced operating time ***(Jay B. Brodsky et al., 2000)***.

Video-assisted imaging system amplifies the function of thoracoscopy. It cannot only magnify the image with the aid of better instruments, but also share the images with all people performing this procedure ***(LUH Shi- ping et al., 2005)***.

## Aim of the work

This essay aims at discussing recent advances in indications, contraindication, pathophysiological considerations in relation to thoracic surgery, cardio pulmonary effects of gas insufflation, anesthetic management and complications of using video-assisted thoracoscopy.

# Indications Of Video-Assisted Thoracoscopy (VATS)

The VATS approach is used for simple diagnostic and therapeutic procedures involving the pleura, lungs, and mediastinum ***(Jay B. Brodsky et al., 2000)*.**

**Indications of Video assisted thoracoscopy are classified into:**

***Diagnostic indications :***

- Undiagnosed pleural effusion.
- Indetermined pulmonary nodule.
- Pulmonary infection in the immunosuppressed patient.
- To define cell type in known thoracic malignancy.
- Nodal staging of a primary thoracic tumor.
- Diagnosis of intrathoracic pathology to stage a primary extrathoracic tumor.
- Evaluation of intrapleural infection.

**Therapeutic indications :**

***Lung :***

- Management of spontaneous pneumothorax.
- Excision of Bullous cyst .
- Lung volume reduction .
- Persistent parenchymal airleak.
- Excision of benign pulmonary nodule .
- Resection of pulmonary metastases. (in some cases)
- Resection of primary lung tumor (in some cases)

**Mediastinum :**

- Drainage of pericardial effusion.
- Excision of bronchogenic or pericardial cyst.
- Resection of selected primary mediastinal tumors .
- Esophageal myotomy.
- Evaluation of the diaphragm in penetrating thoracoabdominal injuries and management .
- Facilitation of transhiatal esophagectomy .
- Resection of primary esophageal tumors.
- Thymic resection.
- Ligation of thoracic duct .

**Pleura :**

- Drainage of multiloculated effusion .
- Drainage of an early empyema.
- Pleurodesis. ***(Bernard Park et al ., 2005)***

**Other indications of video assisted thoracoscopy:**

***Esophagus and diaphragm***

- Tumor staging or resection.
- Repair of diaphragm.
- Anti reflux operations.

**Heart and great vessels**

- Pericardectomy.
- Diagnosis of cardiac herniation after pneumonectomy.
- Ligation of patent ductus (infants).

**Spine and nerves :**

- Dorsal thoracic sympathectomy.
- Splanchnicolysis.
- Drainage of spinal abscess.
- Discectomy.
- Fusion and correction of spinal deformity.

**Trauma:**

- Assessment of injury.
- Control of hemorrhage.
- Evacuation of clot . ***(Jay B. Brodsky et al., 2000)***

**CONTRAINDICATIONS OF VATS**

**A- Absolute Contraindications :**

1- Obliterated pleural space or pleural thickening on the preoperative computerized tomography examination ***(Valerie J. Halpin et al., 2005).***

2- Inability to tolerate one lung ventilation :

All the operations performed with VATS is done under general anesthesia using double lumen endotracheal tube to allow collapse of the lung on the side of the pathology to allow better visualization and exploration of the entire hemithorax. ***(Stoica et al ., 2000)***.

3- Patient with bleeding tendencies or under anticoagulant therapy ***(Valerie J. Halpin et al ., 2005)***.

**B-Relative contraindications :**

Conditions occurring after chest injury such as hemodynamic instability, shock , major hemorrage and uncontrolled high volume air leakage require thoracotomy for satisfactory outcome ***(Valerie J. Halpin et al ., 2005)***.

***Instrumentation***:

Instrumentation for VATS comprises:

(1) Video equipment.

(2) Endoscopes thoracoports.

(3) Staplers.

(4) Thoracic instruments (e.g., lung clamps and retractors) modified for endoscopic use.

(5) Various devices for tissue cauterization, including lasers. Because immediate conversion to thoracotomy is occasionally necessary, a basic set of thoracotomy instruments should be an integral part of a VATS instrument tray ***( Rusch VW,1993).***

# Pathophysiological Considerations In Relation To Thoracic Surgery

**Physiological considerations** :

There are two phases in pulmonary respiration, ventilatory phase and exchange phase. The ventilatory phase is the air movement between the air and the lung parenchyma.The exchange phase is a phase where carbon dioxide and oxygen are interchanged between alveolar air and pulmonary capillaries through alveolar and capillary membranes.There are three principle factors which affect pulmonary respiration namely ventilation ,diffusion and perfusion ***(Benumof, 2005)***.

**VENTILATION:**

An adequate minute volume of ventilation may be defined as: the respiratory minute volume which will ensure satisfactory levels of oxygen and carbon dioxide in arterial blood under prevailing conditions of barometric pressure, composition of inspiratory gas , dead space, distribution shunting, diffusion capacity and metabolic activity of the subject. Normal range of arterial $PCO_2$ is 4.8-5.9 KPa(36-44 mm Hg ).NormaL arterial $Po_2$ varies widely from 9.3-14.7 Kpa (70-110 mm Hg) and markedly depends on age ***(Benumof, 2005).***

## DIFFUSION:

Diffusion refers to the passive movement of molecules across a membrane that is governed primarily by concentration gradient. In this sense, carbon dioxide is 20 times more diffusible across human membranes than is oxygen; therefore, carbon dioxide crosses membranes easily. As a result, hypercarbia is never the result of defective diffusion; rather, it is the result of inadequate alveolar ventilation with respect to carbon dioxide production ***(M. Christine Stock, 2006).***

## PERFUSION:

It is defined as blood flow throughout the lung tissue. As right ventricle contracts, it imparts Kinetic energy to the blood flow in main pulmonary trunk which is dissipated in climbing a steady fall in blood flow per unit alveolar volume with the rib number from the bottom to the apex of the lung when the subject is sitting or upright ( standing ) ***(Benumof, 2005)***.

## Distribution of Ventilation and Perfusion

### Distribution of Blood Flow

Blood flow within the lung is mainly gravity dependent. Thus, blood flow depends on the relationship between pulmonary artery pressure (Ppa), alveolar pressure (PA), and pulmonary venous pressure (PpV) . The lung divided into three zones**.**

Zone 1 conditions occur in the most gravity-independent part of the lung above the level where pulmonary artery pressure is equal to alveolar pressure. Because alveolar pressure is approximately equal to atmospheric pressure, pulmonary artery pressure in zone 1 is subatmospheric but necessarily greater than pulmonary venous pressure (PA > Ppa > PpV).

Alveolar pressure that is transmitted to the pulmonary capillaries promotes their collapse, with a consequent theoretical blood flow of zero to this lung region. Thus, zone 1 receives ventilation in the absence of perfusion and creates alveolar dead space ventilation. Normally, zone 1 areas exist only to a limited extent. However, in conditions of decreased pulmonary artery pressure, such as hypovolemic shock, zone 1 enlarges.

Zone 3 occurs in the most gravity-dependent areas of the lung where Ppa > PpV > PA and blood flow is primarily governed by the pulmonary arterial to venous pressure difference. Because gravity also increases pulmonary venous pressure, the pulmonary capillaries become distended. Thus, perfusion in zone 3 is lush, resulting in capillary perfusion in excess of ventilation, or physiologic shunt . ***(Barash,2006).***