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An Overview on Thoracoscopy for Pleural Effusion

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Abstract:

Pleural effusion, the accumulation of fluid in the pleural space, can be caused by various benign and malignant conditions. In cases of undiagnosed or recurrent effusions, thoracoscopy offers a minimally invasive method for both diagnosis and therapeutic management.

Keywords: Thoracoscopy for pleural effusion, Malignant pleural effusion.

Introduction:

Pleural disease affects more than 300 per 100,000 individuals each year, worldwide. In the United States alone, 1.5 million pleural effusions are diagnosed annually, and represent about a quarter of diagnoses seen by pulmonologists. While history, physical exam and pleural fluid analysis will reveal the diagnosis in a majority of the cases, an estimated 26% of pleural effusions remain undiagnosed and warrant further work up. Many of these undiagnosed effusions are exudative in nature and are especially worrisome, since in low tuberculosis (TB) prevalence areas, more than half of these will be malignant. In TB endemic areas, on the other hand, 84.5% of undiagnosed exudative pleural effusions were eventually found to be secondary to pleural TB **(Allocca et al., 2024a).**

Malignant pleural effusion (MPE) is a devastating illness which portends a generally poor prognosis. Median survival after the diagnosis of MPE is about 6 months but varies considerably, and can now be estimated via several prediction models. MPE leads to 100,000 hospital admissions in the US every year, with lung and breast cancers, and lymphoma being the most common etiologies **(Fortin et al., 2018).**

The challenge for chest physicians is three-fold: First, the diagnosis should be established promptly so that appropriate therapies may be instituted as soon as possible. Second, adequate tissue must be obtained, which allows for advanced contemporary genetic and molecular testing. Third, interventions to palliate the symptoms of MPE must be offered **(Munavvar et al., 2024).**

The procedures currently available for the diagnosis and treatment of pleural effusions include thoracentesis, closed pleural biopsies, image-guided pleural biopsies (ultrasound or CT-guided), thoracoscopy; surgical and medical thoracoscopy pleuroscopy and video-assisted thoracic surgery (VATS) **(Addala et al., 2022).**

Medical thoracoscopy (MT):

Medical thoracoscopy (MT) has variably been referred to as pleuroscopy or local anaesthetic thoracoscopy (LAT). Medical thoracoscopy (MT) is gaining popularity as the procedure of choice for diagnosing and treating exudative pleural effusions, which remain undiagnosed after thoracentesis. Medical thoracoscopy is not a novel procedure: it was first performed by a Swedish internist, Hans Christian Jacobaeus in the early 20th century. Interestingly at that time its main application was adhesiolysis for creation of pneumothorax. With the advent of effective anti-TB medications, pleuroscopy fell out of favor **(Kostroglou et al., 2022a).**

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Video-assisted thoracoscopic surgery:

Since its introduction in 1990s, VATS has replaced open thoracotomy as the preferred procedure for a multitude of thoracic pathologies. While lung resection is the most commonly performed procedure using VATS, it is also regularly utilized for pleural biopsies, pleurodesis, mediastinal resections, esophagectomies and sympathectomies. The main advantages of VATS over traditional open thoracotomy are reduced procedural morbidity and mortality, and faster recovery without compromising the effectiveness **(Shen et al., 2022).**

VATS has traditionally been performed using three chest ports (incisions to allow for instrument insertion), while the patient is under general anesthesia and undergoing single (contralateral) lung ventilation. Recent advances in minimally invasive thoracic surgery include development of robotic-assisted thoracic surgery (RATS), uniportal-VATS (U-VATS) and performance of VATS under conscious sedation. While these advances are blurring the boundaries between VATS and pleuroscopy, these innovative minimally invasive thoracic surgeries are only available at a few centers. The diagnostic yield for VATS is over 90% and is considered the gold standard for the diagnosis of MPE. Overall risk of complications is 4–6%. Most common complications include bleeding (0.5–1.9%), pneumonia (3%), empyema (1.4%), surgical wound infection (1.7%), cancer recurrence at port sites (0.2–0.5%) and post-operative pain. Post-operative mortality has been reported at 2%. However, in a different series of 86 patients from the United Kingdom, no deaths were reported **(Grossi et al., 2023)**

Indications:

Video-assisted thoracoscopic surgery (VATS) is a minimally invasive surgical technique used in the management of pleural effusion, particularly when the effusion is complicated by infection or malignancy. Here are the key indications for using VATS in cases of pleural effusion:

1. **Diagnostic Purposes**:

VATS is highly effective for diagnosing the cause of pleural effusions, especially when fluid analysis is inconclusive. It allows for direct visualization of the pleura and the collection of tissue samples for histological examination **(Hajjar et al., 2016).**

2. **Therapeutic Intervention**:

Drainage of Infected Effusions: VATS can be used to drain infected pleural effusions, such as empyema, where pus accumulates in the pleural space. This is crucial for relieving symptoms and preventing further complications **(Hajjar et al., 2016).**

Pleurodesis: During VATS, a sclerosing agent can be introduced to adhere the pleura together, which helps prevent the recurrence of pleural effusions, particularly in malignant cases.

Debridement: In cases of malignant pleural effusion, VATS can facilitate the removal of thickened pleura or debris, improving lung function and reducing symptoms **(Hajjar et al., 2016).**

3. **Management of Malignant Pleural Effusions**:

VATS is often indicated for patients with malignant pleural effusions, where it can help manage symptoms and improve quality of life. It is particularly useful in cases where the effusion is associated with cancer, allowing for both diagnostic and therapeutic interventions **(Hajjar et al., 2016).**

4. **Failed Conservative Management**:

If initial treatments, such as thoracentesis (needle drainage), are ineffective or if the effusion recurs, VATS may be recommended to provide a more definitive solution.

- **Minimally Invasive**: VATS involves smaller incisions compared to traditional open surgery, leading to reduced postoperative pain and quicker recovery times.
- **Lower Complication Rates**: The minimally invasive nature of VATS generally results in fewer complications, making it a preferred option for many patients **(Hajjar et al., 2016).**

In summary, VATS is indicated in the management of pleural effusions for both diagnostic and therapeutic purposes, especially in cases involving infection or malignancy. Its minimally invasive approach offers significant advantages in terms of recovery and complication rates.

Contra-indications:

Here are the key points organized in a structured format regarding the evolution of Video-Assisted Thoracoscopic Surgery (VATS) and its contraindications:

1. Decrease in Contraindications:

- Over the last three decades, the contraindications for VATS have significantly decreased.
- Surgeons have expanded the indications for VATS and successfully overcome previous challenges.

2. Historical Contraindications:

- Prior chest surgery.
- Neoadjuvant chemotherapy or radiation.
- Central or endobronchial lesions.
- Chest wall involvement.
- Vessel involvement.

3. Current Absolute Contraindication:

The only documented absolute contraindication is the inability to achieve adequate visualization of the hemithorax **(Lesser, 2002).**

4. Limitations in Lung Ventilation:

- Patients who cannot tolerate single-lung ventilation are typically not suitable for thoracoscopic approaches.
- Situations where lung isolation is not possible include:
  - ✧ Previous pneumonectomy on the contralateral side.
  - ✧ Challenging airway anatomy.
  - ✧ Technical challenges with double-lumen endotracheal tube placement or bronchial blockers **(Li et al., 2016).**

5. Adaptability of VATS:

- Brief operations like bullectomy or pleural/lung biopsies can be performed via VATS using intermittent apnea without the need for thoracotomy **(Nguyen et al., 2018).**
- The use of VATS for spontaneously breathing patients, assisted by regional anesthesia and conscious sedation, continues to increase **(Sakakura et al., 2020).**

6. Expanded Applications:

- VATS has been safely employed for procedures involving the lung, pleura, and mediastinum.
- Recent expansions include complex airway surgery, bronchoplastic procedures, and vascular resections/reconstruction **(Pompeo et al., 2007).**

Relative contraindications to VATS include:

1. **Bronchoplastic procedures (sleeve resection)**: These may pose challenges due to the complexity of the procedure.
2. **Chest wall deformities limiting visualization**: These can hinder the surgeon's ability to visualize the surgical site.
3. **Large lesions that limit visibility**: Lesions that would ultimately require a large incision and rib spreading for extraction, with a previously reported threshold of 6 cm.
4. **Central/hilar lesions requiring proximal and/or intrapericardial dissection**: These lesions may require more extensive surgery.
5. **Dense adhesions (due to infectious etiology or previous surgery) requiring decortication**: These can complicate the procedure.
6. **Calcified hilar adenopathy**: This can make dissection more challenging.
7. **Neoadjuvant chemotherapy or radiation with challenging dissection**: Previous treatment may complicate the surgery.
8. **Extensive chest wall involvement**: This can limit the effectiveness of VATS. **(Sagwa et al., 2002)**

The limitations of VATS in redo surgery have been challenged recently, particularly given that thoracoscopic approaches facilitate adhesiolysis and visualization of the pleural space. The debate surrounding VATS as an oncologically sound technique in the setting of non-small cell lung cancer (NSCLC) with N2 disease continues. However, published retrospective series have repeatedly demonstrated comparable efficacy of nodal dissection between both VATS and thoracotomy **(Watanabe et al., 2005).**

Procedure:

As with most surgical procedures, the optimal strategy for managing complications of VATS pulmonary resections is to prevent their occurrence. VATS is a new approach, not a new procedure. Therefore, the preoperative evaluation and indications for VATS major resections remain the same as for conventional resection. Avoiding complications depends on appropriate preoperative workup and patient selection. Planning for as safe a VATS resection as possible involves considering the patient's characteristics, the radiographic appearance of the area of lung to be removed, and the anticipated technical aspects of the case **(Rocco et al., 2011; McKenna et al., 2012).**

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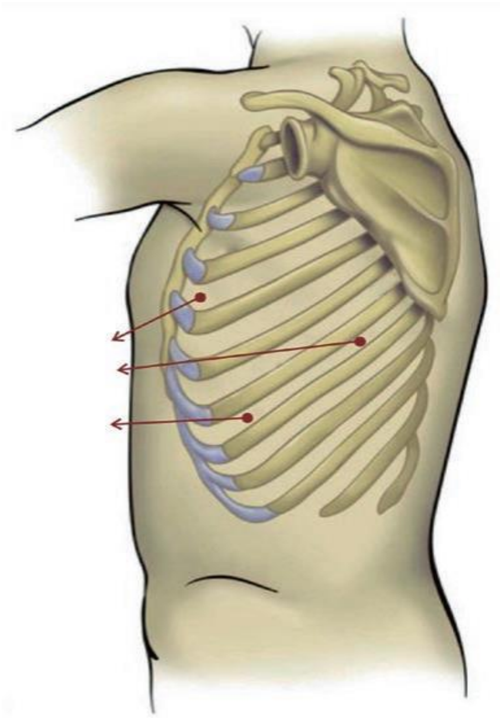
All patients undergo a preoperative examination that includes a positron emission tomography (PET) scan, computed tomography (CT) scan, bronchoscopy, and endobronchial ultrasound/mediastinoscopy for preoperative staging (unless it is benign lung disease or a peripherally-located T1 tumor on PET) **(Hansen et al.,**

2012). Additionally, preoperative evaluation and staging for thoracoscopic resection should include pulmonary function tests (PFTs) with diffusion measurements. The performance of thoracoscopic procedures typically depends on the ability to achieve and maintain single-lung ventilation, which requires careful consideration of the patient's contralateral lung status **(Meyer, 2000).**

Point of entry:

The patients received general anaesthesia with double-lumen endotracheal intubation which was confirmed by fibre-optic bronchoscopy in the contralateral decubitus position, with the thorax surgically prepared in case conversion to an open thoracotomy is necessary during the course of the operation. This is accompanied by flexion of the operating table at the level of the tip of the scapula to widen the intercostal space. The flexion is achieved either by putting a bolster or flexing the operating table, with the operative lung facing up and nonoperative lung in the dependent position. The lateral decubitus position provides adequate access to most thoracic structures which include the lungs, pleura, esophagus, and pericardium among other mediastinal structures. Care must be taken at all times to avoid nerve injury by adequately padding pressure points the patient’s shoulder and arm are extended and secured to a side rest **(Cerfolio, 2007).**

Using sterile techniques, the port site is created by making incisions in the intercostal space. The incisions are parallel to the long axis of the intercostal space. The surgeon must take care that these incisions are in the center of the space to avoid injury to the intercostal nerves that run in a groove at the lower border of the ribs. Then using a hemostat bluntly spread the fascia and muscle layers until the pleural cavity is entered. The first port incision should be at the maximum distance from the target site of dissection or inspection to allow better visualization. Mostly the choice of incision is at the seventh or eighth intercostal space at the anterior to midaxillary line. This incision is best suited for the placement of chest tube at the end of the procedure. Surgical interventions are made over the rib to prevent any injury to the neurovascular bundle. The second incision site is the anterior fourth and fifth intercostal space between the midclavicular and anterior axillary line. The third incision is posterior, at the fifth and sixth intercostal space adjacent to the scapula **(Jones et al., 2015).**



Sixth or seventh intercostal space in mid-axillary line was routinely relied upon for trocar protected thoracoscopic access to the pleural cavity. Subsequent intercostal access at 2-4 sites was achieved under the direct thoracoscopic vision to avoid injury to the underlying lung parenchyma. The entire hemithorax was carefully examined. Any free fluid, pus was aspirated and sent for microbiology examination. A thorough assessment of the pleural and lung surface was done and biopsies were taken from suspected areas of pleura or lung tissue accordingly and were sent for histopathological examination. Also, if required, then VATS assisted decortications, wedge resection or lobectomy was done **(Hajjar et al., 2016).**

Performance:

Video-assisted thoracoscopic surgery (VATS) is the gold standard investigation of an unexplained pleural exudate, achieving a diagnostic yield of 90–95% for unselected effusions **(Page 1989).** It also allows management of the effusion with effective pleurodesis (rates of greater than 90% with talc). Due to the requirement for general anaesthesia, its relative invasiveness and the need for thoracic surgical expertise, VATS is often only performed after initial pleural cytology and closed biopsy have been attempted (which will diagnose 60–75% of cases). In the remaining 25–40% of cytology-negative effusions, VATS still achieves a diagnostic yield of 70% **(Harris et al., 1995).**

We audited the performance of our VATS thoracic surgical service in the investigation and management of undiagnosed pleural exudates, as compared to expected standards from The Royal College of Surgeons of England (RCSE), Society for Cardiothoracic Surgery in Great Britain and Ireland (STS) and British Thoracic Society (BTS) **(Antunes et al.).** We also audited performance against the BTS good practice pleural fluid documentation standard **(Maskell et al., 2003).** Finally, we compared the pleural fluid culture positivity rate from VATS empyema fluid to that obtained at pre-referral, based on the assumption that the VATS empyema fluid rate would be non-contributory to microbiological diagnosis (**Cheng et al., 2022)**.

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