REVIEW ARTICLE

MEDICAL PLEUROSCOPY

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ABSTRACT

Pleuroscopy or medical thoracoscopy are terms used interchangeably to describe a minimally invasive procedure that that provides a window into the pleural space, to perform biopsy of the parietal pleura under direct visual guidance, chest tube placement, and pleurodesis of malignant pleural effusion or pneumothorax in selected patients. Indications, contraindications, and the role of pleuroscopy in a pulmonologist's armamentarium will be discussed in the following review.

INTRODUCTION

Pleuroscopy offers physicians a unique opportunity for the evaluation of the pleural space, and the differences between pleuroscopy and video-assisted thoracic surgery (VATS) are detailed in Table I. In the following brief review we will only discus pleuroscopy (Medical Thoracoscopy).

Pleuroscopy performed by pulmonologists usually takes place in an endoscopy suite with the patient under conscious sedation and spontaneously breathing. The confines of this procedure are restricted to parietal pleural biopsy and chest tube placement under visual guidance, fluid drainage, and talcage in selected patients with malignant effusions or pneumothoraces.[1]

The only absolute contraindication is the lack of pleural space due to adhesions although it can be overcome technically by enlarging the skin incision and digitally dissecting the lung from the chest wall. Since pleuroscopy is performed under conscious sedation with partial lung collapse, these patients must not have severe hypoxemia requiring ventilatory support, unstable cardiovascular status, bleeding diathesis, refractory cough or allergy to the medications used.

PATIENT PREPARATION

Pre-procedure

A detailed history and physical examination are vital components of any preoperative evaluation. CXR, decubitus films, ultrasonography and CT scan aid in the selection of an appropriate entry site, while the patient's health and respiratory status is assessed by complete blood count, coagulation studies, electrocardiogram, arterial blood gas analysis, percutaneous oximetry and pulmonary function test. In preparation for pleuroscopy in a patient with pleural effusion, approximately 200–300 mL of fluid is aspirated from the pleural cavity using a needle, angiocatheter, arrow thoracentesis catheter or Boutin pleural puncture needle. Pneumothorax is induced by the opening of needle to air as the patient breathes until a stable equilibrium is reached. This allows the lung to collapse away from the chest wall and creates a space for trocar insertion. Conversely, the operator may choose to do the procedure directly as he or she enters a fluid-filled pleural space, or with the aid of ultrasonography.

TECHNIQUE

The patient is first placed in the lateral decubitus position with the affected side up and the arm raised above the head. Patient's vital parameters, ECG, blood pressure and oxygenation by means of pulse oximetry are monitored, which can be carried out by a nurse, anaesthesiologist or any other trained pleuroscopist. Local anaesthesia and conscious sedation with intravenous narcotic (fentanyl, demerol or morphine) and benzodiazepine (midazolam) are administered and titrated to patient comfort without compromising respiration. Pleuroscopy is performed with single or double puncture technique. The single puncture, which involves making a 1–2-cm incision in the mid-

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axillary line between the 4th and 7th intercostal spaces of the chest wall, is commonly used for diagnostic pleuroscopy and talc poudrage, while the double punctures are required primarily to facilitate adhesiolysis, drainage of complex loculated fluid collections and lung biopsy. A chest tube or small bore-catheter is usually inserted at the end of the procedure and air is aspirated. The tube can be removed following complete lung re-expansion confirmed on CXR, and persistent air leak is rare if the lung has been carefully avoided during diagnostic pleuroscopy. The patient is monitored in a recovery area and can be discharged on the same day if clinically stable. However, if talc pleurodesis or lung biopsy is performed, the patient requires hospitalization for a period of monitoring and chest tube drainage.

Equipment

Historically rigid instruments are used, and these include: 1) reusable stainless steel or disposable plastic trocars of different sizes (diameter 3-13 mm), 2) rigid telescopes with direct (0 degree) or oblique (30 or 50-degree, oblique) viewing, 3) cold (xenon) light source, 4) endoscopic camera attached to the eye-piece of telescope, 5) video monitor, recorder, printer for still photography, and 6) 5-mm optical or coagulating tooth forceps for pleural biopsy (Figure I).[2]

With the introduction of a semi-rigid pleuroscope (model LTF 160/ 240, Olympus, Japan) similar in design and handling to a videobronchoscope, it now allows the procedure to be performed in an analogous fashion to flexible bronchoscopy. The pleuroscope consists of a handle, and a shaft that measures 7 mm in outer diameter and 27 cm in length. The shaft is made up of 2 sections: 22-cm proximal rigid portion and 5-cm flexible distal end that is movable by a lever on the handle (figure II A). It has a 2.8 mm working channel that accommodates biopsy forceps (figure IIB), needles and other standard accessories used with the flexible bronchoscope. It is also compatible with various electrosurgical and laser procedures, and interfaces easily with existing processors (CV-160, CLV-U40,) and light sources (CV-240, EVIS-100 or 140, EVIS EXERA-145 or 160) made by the same manufacturer for flexible bronchoscopy or GI endoscopy available in most endoscopy units without additional costs. The pleuroscope is inserted through a 10 mm disposable plastic trocar (Olympus, Japan), and allows autoclaving (model LTF 160) that obviates important issues related to asepsis.[3]

Table II describes the type of patient suitable for rigid and semi-rigid pleuroscopy.[1]

CLINICAL APPLICATIONS FOR PLEUROSCOPY

Pleural Effusion of Unknown Etiology

The main indication for pleuroscopy is in the evaluation of pleural effusion of unknown etiology following repeated non-diagnostic thoracentesis and closed needle pleural biopsy.

Cytological examination of pleural fluid is diagnostic in 62% of patients with metastatic pleural involvement,[4] but has less than 20% yield when mesothelioma is encountered.[5] Repetitive large volume thoracentesis achieves a diagnosis of malignancy 65% of the time with the first specimen, and further 27% with the second and 5% with the third. Closed needle biopsy may be successful in 50% of metastatic pleural malignancies,[6] however, the addition of pleural biopsy to pleural fluid cytology merely increases the yield by 10%, and is of little value for tumors confined to the diaphragmatic, visceral or mediastinal pleura. Therefore pleuroscopy for undiagnosed pleural effusion aids in establishing the diagnosis of malignancy in greater than 85% [7] if polypoid lesions, masses, thickened pleura or “candle wax drops” are observed (Figure III); in guiding biopsy of these pleural abnormalities for histologic confirmation and hormone receptor analysis; adhesiolysis to improve fluid drainage as well as in assessing lung expandability or trapped lung during fluid removal without additional imaging studies. Moreover, optimal chest tube placement under visual guidance for empyema drainage, and talc poudrage for recurrence prevention of malignant pleural effusions can be performed at the same sitting (Figure IV).

Although pleuroscopy guided biopsy confers an impressive accuracy of 90-100% for the evaluation of pleural effusions, results might be falsely negative in a small percentage of patients in whom cancer is ultimately diagnosed, and these are often due to extensive adhesions that limit inspection, early malignant mesothelioma with focal abnormalities and grossly normal-appearing parietal pleura, insufficient depth of biopsy, and physician inexperience. New imaging techniques such as autofluorescence and narrow band imaging may aid in improving sensitivity and guide selection of sites for biopsy.[8] Electrocautery has also been incorporated to flexible forceps biopsy to enhance its yield, and full thickness parietal pleural biopsies can be obtained using the insulated tip (IT) diathermic knife during flex-rigid pleuroscopy. Diagnostic yields are 85% superior using IT knife (85%) compared with flexible forceps (60%), notably useful for smooth thickened lesions.[8]

Malignant Pleural Effusion

Malignant pleural effusions affect 660 patients per million population per year,[9] and when malignant cells are detected in the pleural fluid or in pleural tissue, they denote dissemination. In males, lung cancer is the most common malignancy that invades the pleura while it is breast cancer in females,[10] and together they account for 50-65% of malignant effusions. Lymphomas, tumors of the genitourinary and gastrointestinal tracts account for 25%, in the remaining 7-15%, the primary site remains unknown.[11] Median survival of patients with malignant pleural effusions ranges between 3 to 12 months, and is dependent on the primary neoplasm with the shortest observed in lung cancer and the longest in ovarian cancer[12].

The primary goal lies in symptom palliation, and several pleural fluid parameters have been studied to determine prognosis of these patients and to assist physicians in selecting suitable treatment options. A meta-analysis of more than 400 patients with malignant effusions showed that pleural fluid pH 7.28 accurately identified patients with poor survival and helped predict to a moderate degree those likely to fail pleurodesis. Although pleural fluid pH was an independent predictor of survival, only 55% of patients with pH 7.28 died within 3 months.[13] It is arguable that other factors such as patient's health and functional status,[14] response of tumor to therapy as well as lung re-expandability should be considered in the overall management strategy.

Observation is indicated only in asymptomatic patients with small pleural effusions, or in those diagnosed with chemosensitive malignancy such as small cell lung cancer, lymphoma, and breast cancer.[15] For the majority if left untreated, they will increase in size as the malignancy progresses. Patients with symptomatic effusions should undergo therapeutic thoracentesis to assesses the effect of intervention on dyspnea and provides a baseline to assess the time to recurrence.[16] If the patient's dyspnea is not improved by thoracentesis, lymphangitis carcinomatosis, pericardial effusion, pulmonary or tumor embolism, atelectasis from bronchial obstruction, and trapped lung from extensive pleural involvement may be contributory.

However, if the patient's underlying health status is good, one can perform pleuroscopy instead of therapeutic thoracentesis, which might need to be repeated daily until all pleural fluid is removed. Early pleuroscopy not only assesses extent of pleural carcinomatosis and lung expandability, it allows removal of all fluid and pleurodesis at the same sitting.

Lung Cancer

Cancer related pleural effusions occur as a result of direct tumor invasion, tumor emboli to visceral pleura with secondary seeding of parietal pleura, hematogenous spread or lymphatic involvement. It is rare to find resectable lung cancer in the setting of pleural effusion despite negative cytologic examination.[17] Pleuroscopy therefore establishes operative eligibility by determining if the pleural effusion is para-malignant or due to metastases. If pleural metastases are found, talc poudrage can be performed at the same time to prevent recurrence.

Malignant Mesothelioma

The average survival of a patient diagnosed with malignant mesothelioma is 6 to 18 months with death resulting from respiratory failure.[18] Over the last 30 years, the incidence of mesothelioma has been increasing steadily, and accounts for 1% of all deaths.[19] Malignant mesothelioma is suspected when the patient gives a history of asbestos exposure, and shows characteristic radiographic features of a pleural effusion without contralateral mediastinal shift. Diagnosis by pleural fluid cytology and closed needle biopsy is difficult, prompting some physicians to advocate open biopsy by mini or lateral thoracotomy to obtain specimens of sufficient size and quantity for immunohistochemical stains and electron microscopy. Today, conventional pleuroscopy is favored over thoracotomy as pleural specimens obtained with the 5- or 7-mm rigid forceps are not only comparable with open biopsies,[20] it allows staging to be achieved in a minimally invasive manner. Pleuroscopy with semi-rigid instruments on the other hand, raises valid concerns about adequacy of biopsies obtained with the small flexible forceps. Since these issues are unresolved pending future studies, use of rigid 5mm optical forceps is recommended in cases where mesothelioma is strongly suspected.

Mesothelioma is notorious for seeding biopsy and chest tube sites, thus pleuroscopy and chest tube incisions should be placed so that if subsequent therapeutic resection is performed, these sites can be easily excised or prophylactically irradiated.[21] Estimates have suggested that only 1-5% of patients are suitable for curative surgery. For the majority who have advanced disease even at first presentation, aggressive palliation of dysnea via pleuroscopic guided drainage and talc pleurodesis, improved pain control, and prophylactic irradiation of incision sites have resulted in effective symptom control.[22]

Tuberculous Pleural Effusion

The average diagnostic yield from closed needle biopsy in tuberculous (TB) pleural effusion is 69% although a wide range of 28- 88% has been reported. In a prospective study of 100 TB effusions in Germany, immediate histological diagnosis was established by pleuroscopy in 94% compared with 38% by closed needle biopsy. Positive yield from histology and bacteriological cultures was also found to be higher with pleuroscopic guided biopsies than with closed needle biopsy and pleural fluid combined.[23] These results were reproduced in a study conducted in a country with high TB prevalence where diagnostic yield from pleuroscopic-guided biopsy was 98% compared with 80% by the Abram's needle.[24] Many experts therefore recommend that if TB pleuritis is strongly suspected in a patient residing in a high TB prevalent area, thoracentesis and closed needle biopsy would suffice, and pleuroscopy reserved for special circumstances where lysis of adhesions to promote effective drainage of loculated effusions or when large quantities of tissue are required for culture in suspected drug-resistant cases.

Recurrent Pleural Effusions of Benign Etiology

These effusions are usually caused by congestive heart failure, cardiac surgery, nephrotic syndrome, liver cirrhosis, uremia, connective tissue disease and other inflammatory disorders, and pleuroscopy may indicated for evaluation of the pleural space, guided parietal pleural biopsy to exclude neoplastic or infectious etiologies, drainage and talc poudrage which confers success up to 90% in recurrence control.[25]

Empyema and Complicated Parapneumonic Effusions

Pleuroscopy is useful in the management of empyema, and should be performed early in the course of disease where fluid can be easily evacuated and lysis of thin fibrinopurulent adhesions to facilitate pleural drainage.[26] Chest tubes can be placed under direct guidance, even in a complicated pleural space with adhesions, which may aid drainage and hasten clinical resolution of symptoms. However in some cases, the finding of a thick pleural peel, trapped lung or a complicated multiloculated pleural space during pleuroscopy prompts immediate referral for early decortication.

Pneumothorax

In spontaneous pneumothorax, pleuroscopy can reveal blebs and bullae and allow coagulation of blebs as well as prevent recurrence by methods such as pleural abrasion or talc pleurodesis. Although blebs and bullae are better detected with VATS and thoracotomy, investigators have shown that specific treatment of blebs and bullae has not improved the outcome of pleurodesis. This is particularly relevant for a selected group of patients with advanced lung disease and comorbidity, who are at higher risk for general anesthesia, VATS or thoracotomy. In these instances, recurrent pneumothoraces can be effectively prevented by thoracoscopic talc poudrage.[27]

COMPLICATIONS

Mortality from conventional pleuroscopy using rigid instruments is comparable with bronchoscopic transbronchial lung biopsy 0.09- 0.24%,[28], and its complications are listed in Table III. Complications using the semi-rigid pleuroscope on the other hand are rare. In fact, it has been shown to be very safe when performed by pulmonologists trained in conventional pleuroscopy.[29] However, many safety outcome studies involve procedures performed by specialists, and may not reflect actual circumstances with less experienced physicians. Thus the need for adequate and satisfactory training cannot be overemphasized.

CONCLUSION

Pleuroscopy is effective in the evaluation of pleural and pulmonary diseases when routine cytology and closed needle biopsy fail. In many institutions where facilities for pleuroscopy are available, it replaces second attempt thoracentesis and closed needle biopsy for patients with exudative effusions of unclear etiology. Pleuroscopy also offers therapeutic interventions such as break down of loculations in early empyemas, and talc pleurodesis for recurrent malignant effusions and pneumothoraces.

With the introduction of the semi-rigid pleuroscope, similar in design and handling to the flexible bronchoscope, and compatible with standard light sources and video processors available in most bronchoscopy suites pleuroscopy will likely be the object of expanded interest both as a diagnostic and therapeutic tool for pulmonary and critical care specialists experienced in flexible bronchoscopy. Although pleuroscopy is generally safe, it is after all an invasive procedure, and a consultative collaboration between the pleuroscopist, primary care physician, chest radiologist and thoracic surgeons is necessary to assure that patients undergoing this procedures are assessed from all perspectives.

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Table I: COMPARISON BETWEEN VATS AND PLEUROSCOPY

Procedure	VATS	Pleuroscopy
Facility	Operating room	Endoscopy suite
Operator	Surgeon	Pulmonologist
Anesthesia	General	Local
Indications	Stapled lung biopsy, pulmonary nodule resection, lobectomy, pneumonectomy, pericardial window, parietal pleural biopsy, pleural effusion or empyema drainage, invasive procedures	Pleural cavity exploration, parietal pleura biopsy, pleurodesis, chest tube placement under direct visualization

Table II: INDICATIONS FOR RIGID OR SEMI-RIGID PLEUROSCOPY

Patient, Radiological, Endoscopic Characteristics	Type of Procedure and Instrument
Diagnostic pleuroscopy for indeterminate uncomplicated pleural effusion where suspicion of mesothelioma is not high	Semi-rigid pleuroscopy* (better tolerated) or with rigid telescopes under local anesthesias
Trapped lung, radiological thickened pleura, endoscopic infiltrated pleura	Rigid optical biopsy forceps* or with flexible forceps performing multiple bites over same area to obtain specimens of sufficient depth
Mesothelioma is suspected	Rigid optical biopsy forceps*
Pleuro-pulmonary adhesions	Fibrous: Rigid optical biopsy forceps* or semi-rigid pleuroscopy with electrocautery accessories Fibrinous: flexible forceps
Empyema, split pleural sign, loculated pleural effusion	Rigid instruments or converting to thoracotomy for decortication
Pneumothorax with bulla or blebs	Rigid instruments (VATS) for staple bullectomy Talc poudrage

***** preferred

Table III: COMPLICATIONS OF PLEUROSCOPY

- Prolonged air leak
- Hemorrhage
- Subcutaneous emphysema
- Postoperative fever
- Empyema
- Wound infection
- Cardiac arrhythmias
- Hypotension
- Seeding of chest wall from mesothelioma

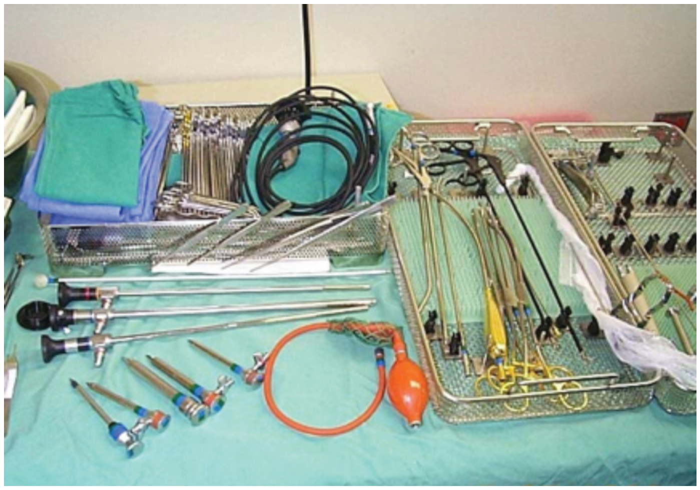
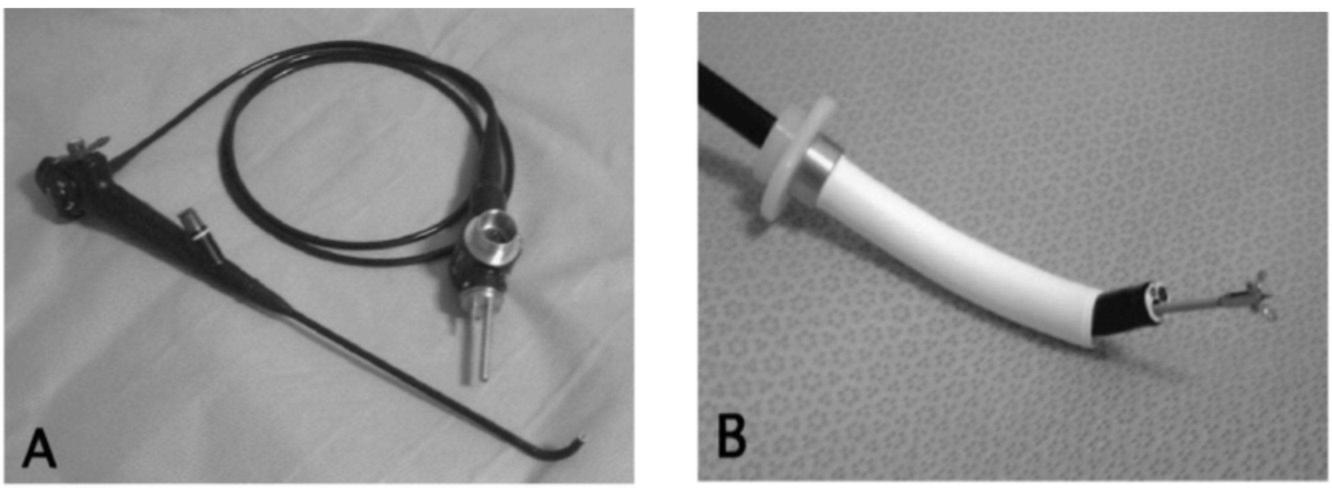


Figure I: INSTRUMENTS USED FOR RIGID THORACOSCOPY



Figures II A and B: Semrigid Pleuroscope inserted with flexible tip and working channel for standard accessories.

Figure III: Polypoid lesions of the parietal pleura suggestive of malignancy

Figure 4: Optimal chest tube placement after talc poudrag