Current Status of Medical Pleuroscopy

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Pleural conditions comprise approximately 25% of cases presenting to pulmonologists. Hence, there has been an increasing interest in novel investigations by pulmonologists in pleural disease. Medical pleuroscopy (MP)—also referred as medical thoracoscopy, local anesthetic thoracoscopy, or video-assisted thoracoscopy—can be performed by nonsurgeons, as distinct from video-assisted thoracoscopic surgery (VATS).

Thoracoscopy was first described by Jacobaeus using rigid instruments in 1910, although the first thoracoscopy was actually performed in 1865 in Dublin.[1,2] The term, MP, describes a different procedure that is similar to VATS.[3] There are differences, however, in that MP is performed by a pulmonologist on (usually) spontaneous breathing patients commonly via a single port whereas VATS is performed via several ports by a thoracic surgeon on an intubated patient with a double-lumen tube. MP is most often a diagnostic procedure (especially for pleural effusion), occasionally for poudrage, whereas VATS is primarily performed with a therapeutic intent. MP and VATS should be regarded as invasive procedures.

PROCEDURAL ISSUES

Patient Selection

Patients with unexplained pleural effusion, pleural infection, and pneumothorax may potentially be suitable for MP. Contraindications include a World Health Organization performance status[4] of greater than 2 unless related to the effusion, uncontrolled coughing, hypoxemia unrelated to the effusion, pulmonary hypertension, unstable myocardial status or function, or a bleeding diathesis. The only absolute contraindication is lack of a pleural space due to adhesions, as a partially collapsed lung is required to safely introduce the pleuroscope into the pleural cavity.

Preprocedure

Detailed history and physical examination are prerequisites as is accurate assessment of functional status of patients. Recent chest radiograph, pleural CT, or pleural ultrasound scan are highly desirable prior to performing an MP along with an electrocardiogram, clotting profile, and complete blood count. The international normalized ratio should ideally be below 1.5 for performing the pleural biopsy and a platelet count greater than 60,000 per μL of blood. Aspirin prolongs the bleeding time but is not a contraindication. Clopidogrel, however, can result in significant bleeding and should be with held 1 week before MP. Efforts to optimize lung function in those with pre-existing obstructive lung disease are helpful. Coughing should also be minimized preprocedure.

MP can be performed in an appropriately sterile endoscopy suite or an operating room. In many institutions, decubitus pleural ultrasound is performed on the day of the procedure, which may

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be particularly helpful if loculations are suspected, to optimize the site of entry and avoid potential technical challenges.[5,6] Alternatively, operators may use a Boutin needle or a similar device to artificially create a pneumothorax and collapse the lung, creating a space for trocar insertion. After placing an intravenous cannula, patients are usually premedicated with an opiate, atropine (intramuscular), and intravenous crystalloid infusion. Routine antibiotic prophylaxis is not indicated provided the environment is sterile and an aseptic technique is used.

Technique

Patients lie in the lateral decubitus position with the abnormal hemithorax uppermost and the arm raised above the head to allow access to the insertion point along the anterior axillary line and to maximize the space between the ribs. Essential monitoring includes respiratory rate, heart rate, blood pressure, oxygen saturations, and electrocardiogram monitoring. Patients usually are breathing spontaneously, without intubation, under conscious sedation with a combination of midazolam and fentanyl or propofol infusion and laryngeal mask airway. Occasionally, assisted ventilation using a propofol infusion via a single lumen endotracheal tube is used for better analgesia; an anesthesiologist's input may be needed in such a scenario. MP thus can avoid the need for more than one port, general anesthesia, or assisted ventilation via a double-lumen endotracheal tube, as is required in VATS.

After infiltration of the skin and the chest wall with a mixture of local anesthetic and adrenaline, blunt dissection to the pleural space is performed in the anterior axillary line (or as guided by lateral decubitus ultrasound) in the same manner as inserting an Argyle intercostal chest tube, typically between the fourth and seventh intercostal spaces. The trocar is inserted with the release valve open. MP can be performed with one or two ports typically and using a rigid or a semirigid scope or a minithoracoscope (discussed later). A single port is used for diagnostic MP and talc instillation whereas the two-port technique may be used if need for diathermy is anticipated. The latter is used to overcome adhesions causing parts of the hemithorax to be inaccessible via a single port, to drain complex effusions, or for more advanced applications, such as lung biopsy.

The effusion is completely drained under direct visualization and then the pleural surfaces are inspected thoracoscopically for optimal biopsy sites and the presence of any evidence of trapped lung. If there are thin adhesions obscuring view, they can be carefully severed but with vigilance for bleeding (very thick fibrous adhesions may often require surgical decortication). Targeted parietal pleural biopsies are taken under direct vision, avoiding the visceral pleura and intercostal vessels, and over a rib if possible. A long sweeping motion is used to obtain the pleura rather than a snap-and-grasp technique. If there is no evidence of a trapped lung with no obvious visceral pleural thickening or adhesions, then a talc poudrage is performed, especially if there is clear evidence of pleural malignancy. At the end of the procedure, a 24-gauge (or larger, especially in cases of pleural infection) chest drain is inserted and removed within a few hours to 3 days, depending on re-expansion of the lung and drainage of the pleural fluid. If the lung is trapped, options are to try a normal chest drain with or without suction or to place a tunneled chest drain for outpatient management. If no talc has been instilled and the lung has re-expanded with the patient stable, the patient could be discharged the same day.

Equipment

Rigid MP uses a light source, endoscopic camera, video monitor, and image capture device with a trocar of between 5 and 10 mm diameter and 5-mm rigid forceps (**Figs. 1** and **2**). Direct or obliqe rigid 7-mm pleuroscopes are available, which

Fig. 1. Rigid pleuroscopy stack system: monitor (*top level*), light source (*top second level*), pleuroscope power supply (*lower second level*), image capture device (*bottom level left*).

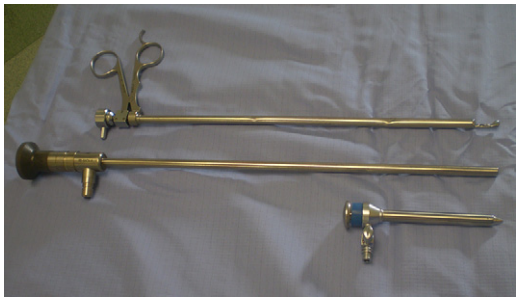

Fig. 2. Rigid biopsy forceps (*upper*), rigid pleuroscope (*middle*) and trocar (*lower*).

provide more panoramic view of the pleural space (**Fig. 3**). Other essentials include sterile drapes and gowns, standard instruments for chest tube insertion, a talc atomizer system, a chest tube (usually 24F–32F), and a negative suction drainage system.

Variants of rigid MP exist. A minirigid MP 3.3-mm telescope with 3-mm biopsy forceps has been used for small loculated effusions inaccessible to the standard size rigid MP scope and larger nonloculated effusions. The diagnostic yield is still favorable at more than 93%.[7] Some operators prefer to use a semirigid thoracoscope in preference to the rigid scope on the basis that pulmonologists find this system easier to learn as it is close to a flexible bronchoscope in its maneuverability.[8,9] The outer diameter of this instrument is 7 mm and it has a 2.8-mm working channel that can accommodate conventional flexible biopsy forceps. It is also compatible with existing processors and light sources used for flexible bronchoscopy, reducing costs. Despite concerns that semirigid thoracoscopy may lead to inferior biopsies that are significantly smaller in size compared with the rigid system, available data suggest that good yields (93%) can be obtained.[10] Comparative studies are awaited. Semirigid MP is probably best reserved for assessment of indeterminate pleural effusions, where the suspicion of malignant mesothelioma is lower, until further data are available. In all other cases, rigid MP is the procedure of choice. Finally, a flexible bronchoscope has been used as a flexible MP but experience has found the rigid MP superior with bigger samples and better yield.[11,12]

Fig. 3. Direct (*upper*) and oblique (*lower*) rigid pleuroscopes.

Complications

MP is a safe procedure when performed by a trained operator. Mortality rates with rigid MP are 0.8% or less in published series, including centers where it has been recently established.[13–15] Complications are few, with reported rates of between 2% and 6%.[16] These include postoperative fever, subcutaneous emphysema, persistent air leak (>7 days), re-expansion pulmonary edema, cardiac arrhythmia, myocardial ischemia, bleeding, empyema, wound infection, and seeding of the chest wall by the neoplastic cells.[17,18] With the semirigid MP scope, complications are expectedly rarer with no reported mortality in published studies to date.[8–10]

INDICATIONS FOR MEDICAL PLEUROSCOPY

Pleural Malignancy—Undiagnosed Pleural Effusion

The main benefits of MP in malignancy are diagnosing pleural metastasis by guided biopsy under direct vision (**Fig. 4**) and providing large amounts of tissue to allow histologic confirmation,[14] histologic differentiation (especially mesothelioma from adenocarcinoma), hormone receptor analysis, and assessment of lung expandability. MP also allows for complete drainage of the effusion, removal of adhesions, and talc pleurodesis, if appropriate, during one procedure in a controlled environment and optimizing chest tube placement.

MP is often needed because of the limitations of less invasive diagnostic techniques. Thoracocentesis is the first investigation into unexplained pleural effusions but pleural cytology is diagnostic

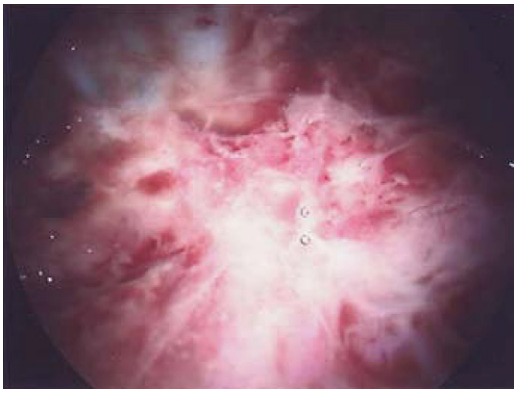

Fig. 4. Metastatic lung adenocarcinoma on parietal pleura viewed at MP.

only in approximately 62% of cases for malignancy, with a much lower yield in mesothelioma and in early cancers, as positive cytology requires malignant cell exfoliation from the pleura into the pleural fluid and adequate cytologic characteristics.[19] Even after further sampling with larger volumes, at least 25% of suspected malignant effusions remain undiagnosed. If there is a high pretest probability of pleural malignancy, then MP is normally indicated at this stage, unless there is an ipsilateral shifting or midline mediastinum in the presence of an effusion, which would suggest main bronchus obstruction, which may require bronchoscopy as an initial diagnostic test.

Closed (ie, not image-guided, using an Abrams needle) pleural biopsy only increases the yield for malignancy over cytology by 7% to 27%.[19] Pleural malignant deposits tend to predominate near the midline and the diaphragm, accounting for the lower yield of closed pleural biopsy compared with CT-guided pleural biopsy or MP.[20] CT-guided pleural biopsy can achieve yields of 87% to 88% for malignancy and 86% for mesothelioma.[20–22] The yield of MP is superior at 90% to 95%.[23,24] MP offers a superior diagnostic option to closed pleural biopsy and advantages (described previously), resulting in a short duration of hospital stay.[14] Although CT-guided pleural biopsy gives a better yield than closed pleural biopsy (87% vs 44%),[20] MP is superior as it allows combined diagnostic and therapeutic options (drainage and pleurodesis) in a single visit, if indicated, with a larger tissue sample for analysis.

Metastatic pleural disease in non–small cell lung cancer precludes surgery and has recently been reclassified from T4 to M1 disease, taking into account the abysmal prognosis for patients with malignant pleural effusion.[25] MP can assess accurately whether or not the effusion is paramalignant or due to metastases, although in clinical practice, VATS may often be performed in this setting by a thoracic surgeon to assess operability.[26] Changes in practice and an increased drive to reduce inpatient hospital stay have resulted in increasing use of MP by the pulmonologists. A recent United Kingdom survey demonstrated that 37 centers now offer an MP service; 15 (41%) of these perform fewer than 20 procedures per year (Dr N. Downer, personal communication, 2009). There have been 218% and 336% increases since 2004 and 1999, respectively.[27]

Pleurodesis

Although low pleural pH due to large tumor burden predicts failure of pleurodesis,[28] MP talc poudrage can be 88% effective even when the pleural pH is less than 7.3.[29] MP talc poudrage (**Fig. 5**) has been shown superior to talc slurry (relative risk of nonrecurrence 1.19) via a normal chest drain in a recent Cochrane systematic review.[30] Although a recent randomized trial did not show an overall superiority for thoracoscopic talc poudrage over talc slurry via chest drain, a subgroup of patients with lung and breast cancer had greater success with talc poudrage (82% vs 67% success at 30 days).[31] In the same study, the proportion of patients with talc-related acute respiratory failure was slightly higher in the poudrage group than the slurry group (8% vs 4%, respectively).

Pleural Tuberculous

For tuberculous (TB) pleural effusion, closed pleural biopsy has a much higher yield than in pleural malignancy due to the more diffuse nature of the pleuritis with combined yield of histology, tissue culture, pleural fluid smear, and culture varying between 80% and 90%.[19] MP remains superior to closed pleural biopsy (100% vs 80% yield), however, in areas with a high TB prevalence.[32] If MP is not locally available, however, closed pleural biopsy is a reasonable first-line investigation in this situation. CT-guided pleural biopsy may be performed yet requires interventional radiologic expertise and a pleural CT.

MP has the advantage over closed and CT-guided pleural biopsy of obtaining a greater amount of tissue, which may be relevant when the diagnosis is in doubt or when there is a need to obtain anti-TB drug sensitivity profiling for suspected drug-resistant cases. MP also allows the simultaneous opportunity to break down adhesions and drain the effusion in a safe, sterile, and controlled fashion, which may be necessary for larger effusions while waiting for response to anti-TB treatment.

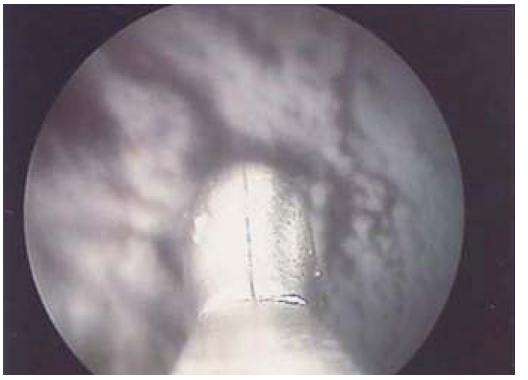

Fig. 5. Standard rigid forceps for MP after talc poudrage.

Pleural Infection and Empyema

In pleural infection, loculations may impede drainage via a conventional chest tube and intrapleural fibrinolysis is not recommended in this context.[33] The exact timing and role of MP remains an area of ongoing debate. Guidelines from the American College of Chest Physicians and the British Thoracic Society do not refer to MP but focus on the role of VATS under such circumstances.[34,35]

MP can be useful early in the course of empyema where thin fibrinous adhesions can be broken down and the fluid and the infected material can be removed to allow lung expansion, providing an opportunity to take targeted biopsies to exclude occult undiagnosed infection or malignancy.[34,36] Further research is ongoing to assess the potential of pleural lavage in pleural infection, which is also possible at MP.

In the later phase of empyema, when there are thick fibrous adhesions (**Fig. 6**),[37] trapped lung, or a pleural peel, early VATS decortication may be required using classic multiport intervention under general anesthesia with double-lumen intubation.[38,39] Expert medical pleuroscopists can also perform MP in empyema in the fibrinopurulent stage, however, and this may be a preferred option in frail or elderly patients, where conventional chest drainage has not been successful and patients are at a high risk for VATS.[40,41] Existing data on MP in pleural infection are sparse but a 93% primary success rate in avoiding surgical intervention has been achieved in early-stage pleural infection.[42]

Pneumothorax

MP can visualize blebs and bullae in patients with spontaneous pneumothorax. Pleural abrasion or talc pleurodesis can be performed or even coagulation of such blebs. MP with talc poudrage may be particularly helpful in the setting of patients with significant comorbidity and advanced lung disease that may not be suitable for VATS[43] and is superior to standard pleurodesis via a chest tube.[44] For suitable patients, VATS or thoracotomy detects blebs or bullae better than MP. VATS bullectomy, pleural abrasion, or pleurectomy is superior to MP for recurrent pneumothoraces.[45] Autofluorescence MP has been used recently to detect areas of potential air leak, which are macroscopically normal on white light MP using inhaled fluorescein.[46]

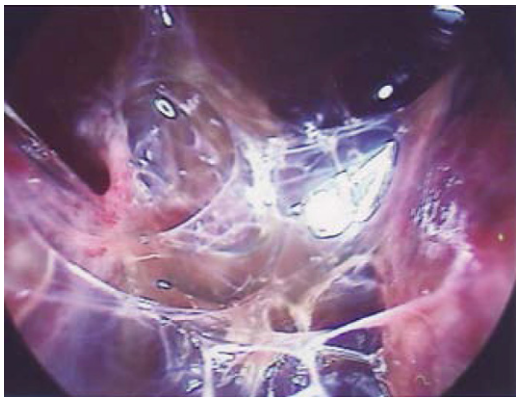

Fig. 6. Chronic sterile empyema at MP with thick fibrous septations and pleural peel.

Other Benign Pleural Disease

If thoracocentesis is unhelpful, MP can also help diagnose other benign pleural disorders in certain settings. The parietal pleura can have a gritty appearance in rheumatoid effusion[47] and asbestos pleural plaques have a characteristic smooth, white, but hard consistency that is difficult to biopsy as a result.

ADVANCED TECHNIQUES AND THE FUTURE

Advanced applications of MP include visceral pleural and lung biopsy and sympathectomy. Other potential applications for the future are being researched.

Visceral Pleural and Lung Biopsy

Visceral pleural biopsy and peripheral lung biopsy can be undertaken at the same time as parietal pleural biopsy at MP, especially when there is coexistence of a pleural effusion with lung disease. This may be important for detecting a synchronous tumor or altering prognosis of a known tumor. Often coagulating forceps may be used via a two-port technique, although a single-port technique is possible with optical forceps without coagulation or using minithoracoscopy.[7]

Lung biopsy via MP for diffuse or localized lung disease is less commonly performed with the advent of VATS wedge lung biopsy and improvement of high-resolution CT.[48] International guidelines from several continents on interstitial lung disease have recommended the use of VATS lung biopsy in particular when indicated.[49,50] VATS wedge biopsies contain more vascular structures than forceps biopsies, with less crush artifact and greater size.[51] Therefore, for pulmonary disorders where vascular integrity is important, forceps biopsy via MP is not recommended.

MP is still occasionally used for diffuse lung disease by some interventional pulmonologists

when bronchoalveolar lavage and transbronchial biopsy have not yielded a diagnosis with good rates of high quality biopsies.[52] For localized lung disease, yields with MP forceps lung biopsy are lower, at less than 50%[53] and this method is no longer used.

Complications with MP lung biopsy are low, the most common are air leaks, but are at similar rates to VATS lung biopsy.[54,55] Bleeding or tissue coagulation is minimal and mortality is extremely low.

Sympathectomy

Sympathectomy has been used for the treatment of hyperhidrosis or chronic pancreatic pain in particular but percutaneous methods are not very effective with high complication rates.[56] Although generally performed by thoracic surgeons at VATS,[57] advanced pleuroscopists have described a single-port technique via a single lumen endotracheal tube using electrocautery.[58,59] Complications of MP for this indication are rare (usually <1%) but include Horner's syndrome, pneumothorax, and hemorrhage.

Future Research Areas

The applications of MP are evolving. Pleuroscopic lavage is under evaluation in the treatment of pleural infection. Autofluorescence pleuroscopy may potentially have an application in detection of early pleural malignancy as autofluorescence bronchoscopy has been utilized for early detection of malignant lesions in the bronchial tree.[60]

FINANCE AND TRAINING ISSUES

Cost Analysis

There are no published cost analyses of MP. A recent United Kingdom tertiary center theoretic cost analysis, however, which compared Abrams or CT-guided pleural biopsies to MP, calculated cost savings of $2198 (£1527) per patient.[14] The cost savings over Abrams needle biopsy, CT-guided pleural biopsy, and VATS are likely to be a combination of reduced need to repeat the procedure, shorter hospital stay, avoidance of thoracic operating room costs, and allowing increased patient flow through interventional radiology and thoracic surgery services. In health care systems operating by tariff-based revenue, accurate coding is essential to allow correct remuneration. Coding errors occur for a variety of reasons and are well described in MP and other specialties.[61,62]

Competency

The American Thoracic Society and European Respiratory Society guidelines on interventional pulmonology do not address MP,[63] although the procedure is regarded as easier to learn than flexible bronchoscopy.[40] The American College of Chest Physicians interventional pulmonology guidelines recommend 20 supervised MP procedures for training and a minimum of 10 per year to maintain skills.[64] The British Thoracic Society is currently revising training guidelines for MP but many centers suggest at least 25 to 30 supervised MP procedures to achieve competency pending the development of formal guidelines. To deliver a robust training program, there needs to be an appropriate service demand in terms of procedures performed per year, which suggests this would not be a procedure for all pulmonologists. Significant demand can occur in tertiary centers despite having thoracic surgery on site.[14]

SUMMARY

MP offers pulmonologists an opportunity to take multiple pleural biopsies to diagnose malignant and nonmalignant pleural diseases. In addition, operators may drain large pleural effusions, break down adhesions, and perform an effective pleurodesis with talc poudrage under direct vision, using conscious sedation. Advanced operators may treat pneumothorax and take lung parenchymal or visceral pleural biopsies.

Close collaboration between the pleuroscopist, thoracic surgeon, and thoracic radiologist is key, as MP remains an invasive procedure requiring training and careful patient selection.

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