

# Medical Thoracoscopy (Pleuroscopy) - State of the Art

Talha Mahmud

Department of Pulmonology, Shaikh Zayed Hospital, FPGMI, Lahore.

## INTRODUCTION

**M**edical thoracoscopy (pleuroscopy) or local anesthetic thoracoscopy refers to the percutaneous insertion of an endoscope into the pleural space under local anesthesia and conscious sedation.<sup>1</sup> For the diagnosis and management of pleural disorders, it has become a standard practice across the globe but in Pakistan, the procedure is practiced in a fewer centers due to lack of training and cost restraints. Pleuroscope can be used to directly visualize both visceral and parietal pleurae and collect specimens from the abnormal lesions.<sup>1</sup> The insertion of the scope through mid-axillary line of the fourth or fifth intercostal space will usually allow complete inspection of the pleura. Exploration of the pleural cavity is accomplished by maneuvering the telescope in a circular manner. Biopsies of suspicious areas are obtained through either the working channel of the thoracoscope or a separate entry site. In a patient with undiagnosed exudative pleural effusion, pleuroscopy is a useful tool to help precisely diagnose the underlying etiology. The primary objective of medical thoracoscopy is diagnosis (particularly for malignant pleural disease), pleurodesis, or both.<sup>2</sup> Besides malignancy, it can be used to accomplish pleural fluid drainage and opening of loculi and adhesiolysis in early empyemas.<sup>1, 2</sup> The procedure is very safe under expert hands and the major contraindication to it is the lack of a pleural space due to extensive pleural adhesions.<sup>1, 3</sup>

## HISTORICAL BACKGROUND

The initial effort to view the pleural space using endoscopic technique (a modified cystoscope) was reported in 1910 by a Swedish physician HC Jacobeus.<sup>4</sup> After his works in the early 20th century, thoracoscopy was widely used to lyse pleural

adhesions or to induce an artificial pneumothorax, a mainstay of therapy for pulmonary tuberculosis.<sup>13</sup> The number of thoracoscopies declined in 1950s after the introduction of effective antituberculous chemotherapy. In addition, the closed pleural biopsy needles (Abrams and Cope) proved reasonably efficacious for the diagnosis of tuberculous (TB) and malignant pleural effusions (MPE), precluding a major role for diagnostic thoracoscopy.<sup>5, 24</sup> In the last two decades, the interest in medical thoracoscopy, has gained potential due to improvements in endoscopic video systems as well as availability of effective premedication such as local anesthetics, sedatives, and narcotics precluding the need for general anesthesia and ventilatory support.<sup>6</sup> Currently, the predominant use of medical thoracoscopy in endoscopy room (Fig. 1) is diagnostic with some extension into the therapeutic



**Fig. 1. Medical thoracoscopy (semi-rigid video pleuroscopy system) performed in a patient with malignant pleural effusion.**

roles, compared to surgeon-led video assisted thoracoscopic surgery (VATS) carried out in the operating room under general anesthesia.<sup>5</sup> As progress continues in both fields, and as pulmonary physician's thoracoscopic experience broadens, it is presumed that many pleural techniques currently

performed by surgeons will come under the domain of pulmonologists.<sup>7</sup>

### METHOD OF ANESTHESIA

Medical thoracoscopy is usually performed under local anesthesia, using 2% lignocaine for infiltration into the skin, subcutaneous soft tissues, and periosteum of the upper and lower ribs.<sup>1,3</sup> This is usually augmented by conscious sedation using a combination of intravenous fentanyl or morphine with or without midazolam for analgesia, sedation, and amnesia.<sup>1,8</sup> Propofol could be used instead of a benzodiazepine, but this may require the presence of an anesthesiologist or at least a nurse anesthetist.<sup>8</sup> Monitoring of cardiac rhythm and cutaneous oxygen saturation or capneometry (if available) is necessary to deal potential complications vigilantly.<sup>1</sup>

### INSTRUMENTS

Both rigid and flexible (semi-rigid) instruments can be used to view the pleural space. The rigid thoracoscope system (single puncture rigid Richard Wolf video thoracoscopy system available in our department (Fig. 2), is currently the most common instrument used globally as it provides both excellent optical quality and maneuverability within the pleural space.<sup>1</sup> Instrumentation can be done through the working channel of the thoracoscope applying probes for palpation and forceps for biopsy or coagulation. Agents for pleurodesis (talc) may be insufflated into the pleural cavity, either through a working channel within the scope or through a separate puncture site at a different intercostal space.<sup>1,7</sup> In an effort to combine the best features of the flexible and rigid instruments, a semirigid fiberoptic videopleuroscope has been developed (Olympus model XLTF-160).<sup>9</sup> The pleuroscope is built on a bronchoscope platform, therefore, the handle, suction and biopsy port are similar to those of a flexible bronchoscope. In addition, it is compatible with flexible bronchoscopic light sources and video processors.<sup>9, 10</sup> The proximal portion of the pleuroscope is rigid, while the tip can be flexed or extended in a manner identical to that of a flexible fiberoptic bronchoscope.<sup>10</sup> Its similarity to the

standard flexible bronchoscope makes it easy to use and the image quality has significantly improved. Over a passage of time, this system may gain more popularity over the rigid pleuroscopes.<sup>7</sup>



Fig. 2: Richard Wolf single portal video pleuroscopy system with trocar, biopsy forceps and dissecting probes.

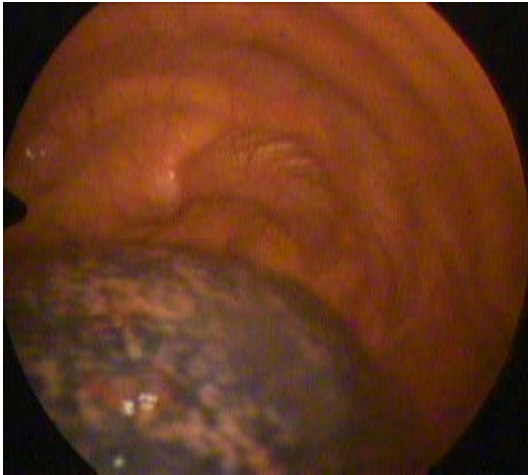


Fig. 3: Olympus XLTF-160 single portal video pleuroscopy system with biopsy forceps.

### TECHNIQUE

Patients are prepped and sterilely draped in the lateral decubitus position on the operating table/couch with the effected lung uppermost.<sup>1, 11</sup> A partially collapsed lung is necessary to safely introduce the thoracoscope into the pleural space. Pleural fluid may be aspirated under local anesthesia and replaced with air. When no pleural fluid is present, a pneumothorax may be induced using a Boutin needle, which has an atraumatic tip that will enter the pleural cavity with the least risk of lung injury.<sup>11</sup> The site of trocar insertion depends upon

the anticipated location of the abnormality which can be undertaken utilizing bedside on-site pleural ultrasound.<sup>1, 12</sup> After the initial preparation, a 10 mm skin incision is made above the superior rib margin. Blunt dissection is performed with an artery forceps through the intercostal muscles and parietal pleura. A blunt-tip trocar and cannula are then introduced carefully to avoid lung injury.<sup>1</sup> The mid-axillary line of the 4th or 5th intercostal space will usually allow complete inspection of the pleura.<sup>11</sup> After suctioning all pleural fluid, further evaluation of the pleural cavity (Figs. 4, 5) is accomplished by maneuvering

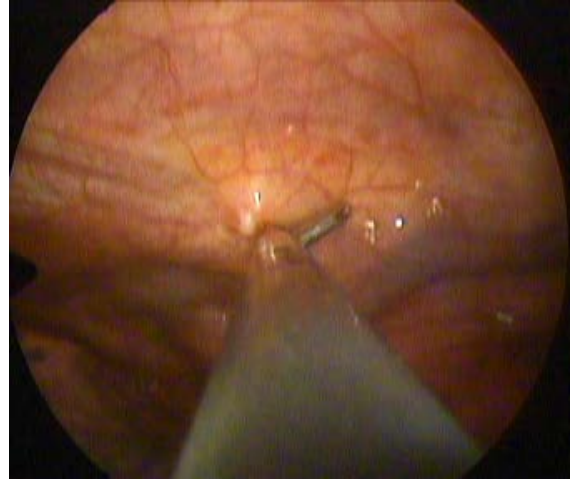


**Fig 4:** Thoracoscopic view of the chest wall/visceral pleura (above) and the anthracotic lung/visceral pleura (below) in a patient with malignant pleural disease.

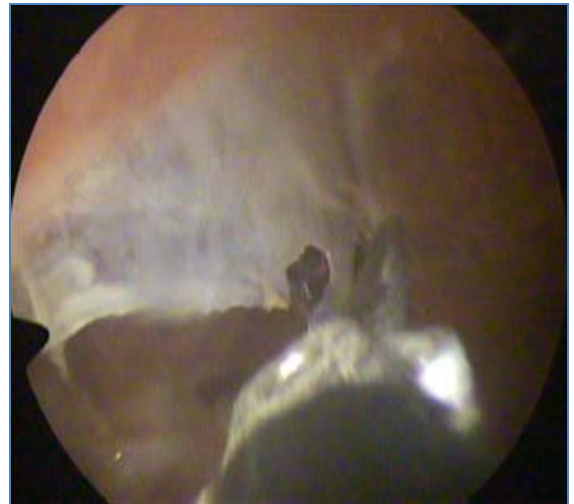


**Fig. 5:** Malignant pleural nodules in costophrenic angle in a patient with metastatic renal cell carcinoma.

the white light telescope in a circular manner. Biopsies of abnormal/suspicious areas (Fig. 6) are obtained through either the working channel of the thoracoscope or a separate entry site. Adhesions, which may interfere with complete examination of the pleural cavity, can be lysed with either a blunt probe or cautery forceps (Fig. 7), carefully avoiding



**Fig. 6:** Biopsy of a malignant pleural nodule located on the parietal pleura in a patient with metastatic adenocarcinoma of lung.



**Fig. 7:** Adhesiolysis through biopsy forceps in a patient with multiloculated pleural empyema.

the vascularized adhesions. If the distance between the lung and the chest wall is small, air can be cautiously introduced to collapse the lung further and enlarge the pleural space.<sup>11</sup> At the completion of



Fig. 8: Thoracoscopic talc insufflations: Pleural talc deposits seen on both visceral and parietal pleural surfaces.

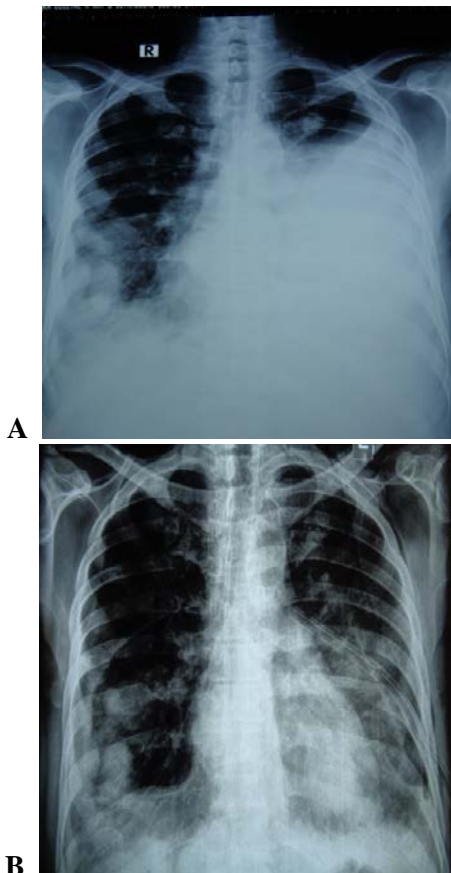


Fig. 9: Pre-thoracoscopy image (a) showing small right & large left malignant pleural effusion and image (b) chest tube placement in the left pleural space after thoracoscopy, in a patient with metastatic renal cell carcinoma (thoracoscopic image shown in Figure 5).

the procedure, a chest tube is inserted through the same opening for removal of air and remaining fluid (Fig. 9).<sup>11</sup> The chest tube can be removed within a few hours when thoracoscopy does not involve a lung biopsy or pleurodesis. If thoracoscopy is done for pleurodesis (Fig. 8), the chest tube should be left in place until any air leak has resolved and the pleural fluid drainage is less than 150 mL per day.<sup>1,11</sup> External negative suction at -10 to -20 cmH<sub>2</sub>O may be applied in selected cases and a daily chest radiograph is obtained to assess lung re-expansion until the patient is discharged from hospital.<sup>1</sup>

### DIAGNOSTIC INDICATIONS OF PLEUROSCOPY

The major indication for diagnostic medical thoracoscopy is an exudative pleural effusion of unknown etiology.<sup>1</sup> Often at the time of thoracoscopy, the etiology turns out to be lung cancer, tuberculosis, mesothelioma, or a benign pleural disorder. In some expert hands, medical thoracoscopy is used to evaluate pulmonary parenchymal disease.<sup>1,12</sup>

#### Pleural Effusion of Unknown Etiology

Medical thoracoscopy in patients with a pleural effusion of unclear etiology often yields a specific diagnosis.<sup>6</sup> Thoracoscopy resulted in a diagnosis of malignancy in 150 (70%) of the patients, including mesothelioma in 35 subjects.<sup>6</sup> The primary question in an exudative pleural effusion of unknown etiology is whether there is presence of malignancy or not, and it is in answering this that pleuroscopy come into its own.<sup>13</sup> One study found a 96% diagnostic accuracy for thoracoscopy, with a sensitivity of 91% and specificity of 100%.<sup>14</sup> The negative predictive value for the diagnosis of pleural malignancy, with a follow-up of two years, was 93%. Similarly, a retrospective study of 138 patients reported an overall diagnostic efficacy of 97%, including 93% for carcinoma, 100% for mesothelioma, and 94% for tuberculosis.<sup>15</sup> In cases where thoracoscopy does not reveal an etiology and the pleural fluid remains or returns after some time, repeat thoracoscopy can be performed without an increase in the duration of

**Table 1: Diagnostic and complications rate from malignancy from 11 largest series of diagnostic medical thoracoscopy.<sup>13</sup>**

Study	Total patients	Diagnostic rate of malignancy (%)	Mortality (%)	*Major Complication Rate (%)	**Minor Complication Rate (%)
Macha et al, 1993	687	94	0	0.6	'Very few'
Boutin and Ray, 1993	188	98	0	2.1	6.9
Hansen et al, 1998	146	90.4	0	2.1	1.4
Sakuraba et al, 2006	138	97.1	0	0	'Few'
Metintas et al, 2010	124	94.1	0	2.4	17.7
Medford et al, 2009	124	97.4	0.8	4.0	n/a
Kapsenberg, 1981	115	95	0	0	0
Menzies & Charbonneau, 1991	104	93.1	0	5.8	1.9
Wilsher & Veale, 1998	58	85	0	6.9	n/a
Brims et al, 2012	57	97.5	0	28.1	19.3
Watanabe et al, <sup>20</sup> 2014	56	93.8%	0	0	3.5

**n/a:** Not available \*Pneumonia, empyema, significant hemorrhage, persistent air leak or pneumothorax, and port site metastasis  
**\*\***Port site infection, transient hypotension, pyrexia and minor bleeding.

the procedure or other morbidity.<sup>16</sup> Progress has also been made in image guided biopsy techniques and by using pleural-based contrast CT scanning, radiologists are now increasingly able to identify cancerous pleural infiltration with accuracy superior to blind methods and highly comparable to thoracoscopic biopsy.<sup>17</sup>

### Lung Cancer Staging

Most pleural effusions associated with lung cancer result from direct pleural carcinomatosis. In a patient known to have lung cancer and a cytology negative exudative pleural effusion, pleuroscopy may help to stage the malignancy as stage IV thus preventing unnecessary surgery.<sup>18</sup> The diagnostic rate of pleural malignancy by thoracoscopy ranges from 85% to 98% (Table 1) in different series. Even patients with negative pleural fluid cytology usually have unresectable tumors. As an example, one study of 73 patients with lung cancer and ipsilateral cytologically negative pleural effusions found completely resectable tumors in only 6%.<sup>19</sup> In such patients, thoracoscopy is a preferable method to identify the small group who could potentially benefit from surgical resection.

### Malignant Pleural Mesothelioma

Although malignant mesothelioma may be clinically suspected, it is often difficult to diagnose because closed needle biopsy specimens are rarely

of sufficient size to allow a definitive diagnosis.<sup>1</sup> Even by thoracoscopy, the accuracy of diagnosing mesothelioma may suffer because of inadequate visualization due to extensive adhesions and the inherent difficulties in pathological identification (electron microscopy and extensive immunohistochemistry needed) of the tumor. Diagnosis is established thoracoscopically in 60 to 75% of patients, compared to 88% with open thoracotomy.<sup>16</sup> In case if future surgical resection is not a consideration, thoracoscopy permits pleurodesis at the time of diagnosis.<sup>18</sup>

### Pleural Tuberculosis

Abrams' closed (blind) pleural biopsy has a diagnostic yield of 70 to 90% in exudative pleural effusions due to tuberculosis.<sup>21</sup> The thoracoscopic appearance of tuberculous pleural lesions is usually that of extensive grayish-white granulomas involving the parietal pleura.<sup>22</sup> Significant adhesions may concentrate in the costovertebral angles.<sup>22</sup> At other times, the appearance is simply that of patchy pleuritis. In a prospective trial, thoracoscopy was found to have a combined culture/histology sensitivity of 100% compared with 79% for Abrams pleural biopsy.<sup>23</sup> The technique with the highest diagnostic rate for tuberculous pleuritis on the basis of published evidence is therefore local anaesthetic thoracoscopy.<sup>21</sup> However, since blind pleural biopsy has reasonably high sensitivity and is cost effective,

it should often be the procedure of first choice in resource-poor areas with a high incidence of TB.<sup>23</sup> However, thoracoscopy may be useful in several circumstances including difficult diagnostic situations, when lysis of adhesion is necessary or when larger amounts of pleural tissue are necessary for determination of drug resistance.<sup>1,22</sup>

### **Pulmonary Parenchymal Disease**

Thoracoscopic lung biopsy has been advocated when less invasive techniques, such as fiberoptic bronchoscopy with transbronchial lung biopsy, bronchoalveolar lavage, or fine needle aspiration biopsy, have failed to establish a diagnosis.<sup>11</sup> Thoracoscopic pinch lung biopsy can help establish the diagnosis of diffuse pulmonary disease, pulmonary infiltrates, or peripheral lesions of unknown cause.<sup>1</sup> In the hands of pulmonary physicians, the technique requires expertise with availability of surgical staples to ensure hemostasis and to avoid air leaks. A clear advantage of thoracoscopy over bronchoscopy for lung biopsy is that larger pieces of representative lung tissue can be obtained.<sup>11</sup> As thoracoscopy becomes more widely available, patients who require biopsy for either localized or diffuse disease may be offered a diagnostic approach intermediate to that currently available from bronchoscopy and open lung biopsy. Nonetheless, a formal surgical lung biopsy currently remains the recommended definitive investigation for diffuse parenchymal lung disease (interstitial lung disease) globally and is likely to remain so in the foreseeable future.<sup>13</sup>

### **Other Benign Pleural Disorders**

If appropriate initial pleural fluid studies are non-diagnostic, thoracoscopy may help establish the diagnosis of benign diseases like uremic pleuritis, rheumatoid pleurisy, pleural asbestosis and pleural sarcoidosis.<sup>13</sup> Among patients with recurrent pleural effusions in benign disorders, more importantly, pleuroscopic evaluation, evacuation and biopsy can help ruling out tuberculosis or malignancy.<sup>1</sup> Uremic effusions sometimes resistant to hemodialysis (fibrinous pleuritis on pleural biopsy) may require thoracoscopic biopsy (to rule out TB/malignancy) and/or pleurodesis for their control.<sup>25</sup> Pleural asbestosis is characterized by hyaline and calcified

plaques which have distinctive endoscopic characteristics, appearing smooth and white.<sup>14, 15</sup> Direct biopsies are difficult to obtain because of the extremely hard consistency of these plaques. In rheumatoid pleural effusions, the visceral surface usually shows nonspecific inflammation, and the parietal surface has a gritty appearance.<sup>26</sup> Many small vesicles or granules can be identified on the parietal pleura in rheumatoid involvement.<sup>15, 26</sup>

## **THERAPEUTIC INDICATIONS OF PLEUROSCOPY**

### **Talc Pleurodesis in Malignant Pleural Effusion**

The most widely employed therapy for treatment of malignant pleural effusion or recurrent benign pleural effusion involves drainage by tube thoracostomy followed by instillation of sclerosing agents to achieve chemical pleurodesis.<sup>1</sup> Requirements for successful pleurodesis include even distribution of the sclerosing agent over all pleural surfaces and expansion of the lung to the chest wall. In theory, thoracoscopic talc poudrage (i.e., insufflation) may increase the likelihood of successful pleurodesis in difficult cases by improving talc distribution over the pleural surfaces. Talc pleurodesis via pleuroscopy has been shown to be equally effective (>90%) to open thoracostomy and talc poudrage, but with lower morbidity and mortality rates.<sup>1</sup> It is uncertain whether the technique for administering talc affects the outcome. In the meta-analysis described above, non-recurrence of the effusion was more likely following thoracoscopic insufflation of talc, compared to bedside instillation of talc slurry through a chest tube (RR 1.19, CI 95% 1.04-1.36).<sup>27</sup> In contrast, a multicenter trial that randomly assigned 482 patients to either thoracoscopic insufflation of talc or bedside tube instillation of talc slurry demonstrated equal efficacy at 30 days (78 versus 71%).<sup>28</sup>

### **Talc Pleurodesis in Resistant Benign Effusions**

The primary aim of a transudative pleural effusion due to a systemic cause is to treat the underlying disease.<sup>1</sup> However, a resistant and recurrent pleural effusion due to a benign disorder may require control and chemical pleurodesis via chest tube placement or thoracoscopic talc

pleurodesis may be tried in selected refractory cases.<sup>4, 14</sup> Several types of nonmalignant pleural effusion have been successfully managed by pleurodesis, including those due to chronic ambulatory peritoneal dialysis, yellow nail syndrome, chylothoraces, nephrotic syndrome, lupus pleuritis, and heart failure with hepatic hydrothorax having high failure rates.<sup>29</sup>

### **Pleural Infection and Empyema**

It is universally agreed that complicated pleural infection and empyema requires drainage, unless a late stage fibrothorax has developed that requires VATS.<sup>13</sup> Successful chest tube drainage of an empyema is difficult and an interventional procedure is frequently required to remove the infected pleural fluid.<sup>1, 13</sup> The use of medical thoracoscopy in this setting has been reported. In a series of 127 patients with empyema, medical thoracoscopy successfully drained the pleural space of 116 patients (91%).<sup>30</sup> However, four patients (3%) required either an additional chest tube or a second thoracoscopy and 62 patients (49%) required post-procedure intrapleural fibrinolytic agents over 3-5 days.<sup>30</sup> Further larger studies are needed to clarify the role of medical thoracoscopy in pleural infections and empyema.

### **Pneumothorax**

Pleuroscopy is sometimes performed in patients who have persistent pleural air despite aspiration, secondary spontaneous pneumothorax, second ipsilateral primary spontaneous pneumothorax or a first contralateral episode.<sup>13</sup> Common pleural abnormalities visualized during local anesthetic thoracoscopy include a normal visceral pleural appearance (39 %), small (< 2 cm) blebs on the pleura (31 %), large ( $\geq$  2 cm) blebs (17 %), and pleural adhesions (%).<sup>31</sup> Small blebs can be successfully obliterated by pleuroscopy using argon beam coagulation, Nd:YAG laser, or electrosurgery. This is typically followed by pleurodesis, which can be accomplished chemically (eg, instillation of talc), mechanically (eg, pleural abrasion), or by laser coagulation of the pleura.<sup>32</sup> Patients with large ( $\geq$  2 cm) blebs or bullae may require surgical or VATS resection. Open surgical bullectomy is still preferred for extensive bullous disease, but VATS is often

used to treat less extensive disease.<sup>31</sup> Medical thoracoscopy is seldom used to treat large blebs or bullae, although treatment with thoracoscopic talc poudrage may be successful.<sup>31, 32</sup> The expected expanding role of pleuroscopy in the management of pneumothoraces is still being studied and requires further clarification through larger randomized control trials.

### **Sympathectomy**

Local anesthetic thoracoscopy has been used to perform sympathectomy for palmar hyperhidrosis.<sup>33</sup> However, this requires thorough training, sophisticated expertise and should only be performed in specialized centers having thoracic surgical backup support.

## **POTENTIAL COMPLICATIONS OF THORACOSCOPY**

**Minor complications** (5.6%) of medical thoracoscopy include pain, hypotension, hypoventilation, minor bleeding, port site infection, subcutaneous emphysema (2%), post operative fever (16%) and persistent air **leak > 7days (2%); major complications** (1.9%) include empyema, pneumothorax, bleeding requiring open thoracostomy and rarely death (0.24%).<sup>6, 11, 34</sup> Although risks are low, precautions should include monitoring of blood pressure, cardiac rhythm, and oxygenation.<sup>8</sup> Maintenance of adequate hemostasis is also essential after pleural biopsies. Repeat medical thoracoscopy can be performed without significant mortality or morbidity.<sup>35</sup>

## **CONTRAINDICATIONS**

As with any intervention, the clinician must routinely evaluate the risks and benefits of the procedure and should rule out any contraindication before taking its start.<sup>8</sup> Relative contraindications are uncontrolled cough and hypoxemia that is not due to the pleural effusions. Major contraindications to thoracoscopy include the lack of a pleural space due to pleural adhesions, inability to lay supine, inability to tolerate a pneumothorax, severe cardiac disease (recent myocardial infarction within 2 weeks), severe respiratory disease unrelated to the

pleural effusion, and severe coagulopathy.<sup>36</sup> When a lung biopsy is being considered, an additional consideration is whether pulmonary hypertension, honeycomb lung, or a vascular tumor is present.<sup>1, 13</sup>

### FUTURE DEVELOPMENTS

In the last ten decades or so, thoracoscopy has played a significant role in the workup of pleural effusions of various etiologies. Minithoracoscopy using scope and a forceps (4 mm each) can primarily be applied to predominantly obtain diagnostic pleural biopsies and thus may be useful in highly selected cases like those with narrow intercostal spaces.<sup>13</sup>

Narrow band imaging and fluorescein-enhanced autofluorescence thoracoscopy (FEAT) or 'blue light thoracoscopy' enhances traditional white light thoracoscopy, with many high grade lesions detected by FEAT in areas that appeared normal during white light thoracoscopy.<sup>37</sup>

With further advancements in other less-invasive techniques like pleural fluid cytological evaluation and using better immunohistochemical and molecular markers (having high sensitivity for most metastatic carcinomas including mesothelioma), need for tissue biopsy may decline.<sup>38</sup> Radiological imaging-guided biopsies are attractive alternatives which may obviate the need for thoracoscopic biopsies and are gaining popularity across the globe. Examples include ultrasound and CT-guided bedside pleural biopsy with enhancement of fluorodeoxyglucose positron emission tomography (FDG-PET)-avid areas in selected cases.<sup>39</sup>

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### Conflicts of interest

None.

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**The Author:**

**Dr. Talha Mahmud MD, FCPS**

Associate Professor & Consultant Pulmonologist  
Head, Department of Pulmonology,  
Shaikh Zayed Hospital, FPGMI, Lahore, Pakistan.  
drmtalha@hotmail.com

**Corresponding Author:**

**Dr. Talha Mahmud MD, FCPS**

Associate Professor & Consultant Pulmonologist  
Head, Department of Pulmonology,  
Shaikh Zayed Hospital, FPGMI, Lahore, Pakistan.  
drmtalha@hotmail.com