Diagnostic utility of medical thoracoscopy in peripheral parenchymal pulmonary lesions

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Abstract Introduction: Visceral pleural biopsy and peripheral lung biopsy can be undertaken at the same time as parietal pleural biopsy during medical thoracoscopy, with or without coexistence of a pleural effusion with lung disease.

Objective: To assess the accuracy and safety of medical thoracoscopy for the evaluation of peripheral parenchymal pulmonary lesions.

Patients: We studied 15 patients with peripheral parenchymal pulmonary disease, the cause of which had not been determined after initial investigations, including needle biopsy and thoracentesis if pleural effusion is present. Two patients have solitary peripheral lesions while thirteen have diffuse pathology. Seven patients have pleural effusion in addition to parenchymal lesions.

Methods: Only one patient had thoracoscopy under general anaesthesia while the remaining fourteen were given local anaesthesia with mild sedation. Visually directed biopsies were taken from the lung using electrocautery in all patients. Biopsies were taken also from the parietal pleura in only seven patients.

Measurements: We recorded clinical characteristics, laboratory data, findings and duration of thoracoscopy, and any complications associated with the procedure.

Results: A definitive diagnosis was established in 12 patients: 4 patients had primary bronchogenic carcinoma while 5 patients had metastases. Only 3 patients had benign parenchymal disease. Overall, thoracoscopy had a sensitivity of 80% for the diagnosis of peripheral parenchymal pulmonary lesions. Thoracoscopy was well tolerated under local anaesthesia and entailed hospitalization for less than 48 h in most cases. No deaths occurred, although 6.7% of patients had major complications, and 20% had minor complications.

Conclusions: Among patients with peripheral parenchymal pulmonary lesions remaining undiagnosed after usual initial investigation and even transthoracic needle biopsies, thoracoscopy done under local anaesthesia is a rapid, safe, and well-tolerated procedure with an excellent diagnostic yield that is equivalent to that of thoracotomy.

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Introduction

The pleura is the serous membrane that covers the lung parenchyma, the mediastinum, the diaphragm and the rib cage. This structure is divided into the visceral pleura and the parietal pleura. The visceral pleura covers the lung parenchyma, not only at its points of contact with the chest wall, diaphragm and mediastinum but also in the inter-lobar fissures. The parietal pleura lines the inside of the thoracic cavity and is subdivided, according to the intrathoracic surfaces that it lines, into the costal, mediastinal and diaphragmatic parietal pleura [1,2].

Thoracoscopy was first done by Jacobeus in 1910, primarily to break adhesions to induce artificial pneumothorax in tuberculous patients using a cystoscope [3,4]. Currently, the most common indications for thoracoscopy include diagnosis of the unknown exudative effusion, staging of malignant mesothelioma or bronchogenic carcinoma, and treatment of malignant or other recurrent effusions or empyema. Other less common indications include, taking biopsies from the diaphragm, lung, mediastinum and pericardium, resection of small peripheral lung lesions treatment of spontaneous pneumothorax, sympathectomy for palmar and axillary hyperhidrosis, resection of mediastinal masses and treatment of resistant pericardial effusion [5].

Diffuse lung disease with involvement of the lung periphery, has been an area of application of this technique in the past, and was used recently when a conclusive diagnosis could not be obtained by a less invasive method, e.g. bronchoalveolar lavage (BAL) and transbronchial biopsy (TBB). Various diseases, such as granulomatous diseases [9] have been studied in particular sarcoidosis and invasive mycosis, idiopathic interstitial pneumonias, bronchoalveolar carcinoma, carcinomatous lymphangitis and histiocytosis X. The same occurred for the diagnosis of localized lung disease and chest wall lesions, though used infrequently, as demonstrated by the literature sometimes preceded by transthoracic needle aspiration.

Surgical lung biopsy, on the other hand, is an important diagnostic procedure [10,11] though its related morbidity and mortality have limited most of its indications to the failure of other closed techniques, or to clinical situations where large amounts of tissue are required at once.

Forceps lung biopsy during thoracoscopy under local anaesthesia has been used for many years by pulmonologists and has been frequently described as an integral technique of medical thoracoscopy [12].

Patients and methods

This study included 15 patients with peripheral parenchymal lung lesions admitted to the chest department, Alexandria main university hospital in the period between May and December 2013. All patients had documented peripheral parenchymal lung lesions of undetermined etiology. The procedure was contra-indicated in patients with one of the following findings: coagulation deficit (prothrombin level < 50% or platelet count < 70,000 cells mm), severe respiratory insufficiency (arterial oxygen tension < 60 mmHg), arterial carbon dioxide tension (Pa, CO2) (> 60 mmHg); mechanical ventilation; radiological signs suggesting important pleural adhesions or major bullous degeneration of the lung.

Medical rigid thoracoscopy

Thoracoscopic examination was done using rigid thoracoscopy [KARL STORZ HOPKINS Straight Forward Tele-scope 0 with parallel eyepiece diameter 10 mm, length 27 cm, autoclavable, fiberoptic light transmission incorporated with a 6 mm instrument channel, Trocar size 11 mm consisting of Trocar only with blunt tip Cannula, Click line BLAKESLEY Dissecting and Biopsy Forceps, rotating, with a connector pin for unipolar coagulation, size5 mm, length43 cm, single action jaws].

Patients usually are breathing spontaneously, without intubation, under conscious sedation with either midazolam or propofol. Occasionally, assisted ventilation using a propofol infusion via a single lumen endotracheal tube is used for better analgesia; an anaesthesiologist’s input may be needed in such a scenario.

In cases without pleural effusion, we used the method described by BOUTIN and coworkers. A pneumothorax was induced by the introduction of ~600 mL of air into the pleural space through a smooth ended pleural needle before skin incision.

After raising a 2 cm subcutaneous wheal and anaesthetizing the skin, subcutaneous tissues, muscle planes, rib periosteum and parietal pleura by about 30 cc of 2% lidocaine. A 2 cm transverse skin incision was made by a scalpel parallel to the rib along the intercostal space chosen for tube insertion in the wheal. Blunt dissection of the intercostal tissues was performed by spreading a straight Kelly clamp both parallel and perpendicular to the underlying muscles which were separated and the parietal pleura was gently palpated by the index finger and was penetrated by the Kelly clamp. The trocar is inserted with the release valve open.

After drainage of the fluid, rigid thoracoscopy was introduced through the trocar into the pleural space. The parietal pleura including the costal, diaphragmatic sometimes mediastinal pleura as well as the visceral pleura were thoroughly examined for any lesions such as nodules, plaques, adhesions, thickening, motting or anthracosis. Multiple forceps biopsies were taken from the visceral pleura and lung by a coagulating forceps connected to electrocautery set at 60–100 W can coagulate and seal the cut surface. Multiple forceps biopsies were taken also from any suspicious gross pathological lesion in the parietal pleura if present. The biopsies were then sent for histopathological diagnosis.

Close observation for any complication was carried out and recorded. The complications were then managed.

Results

See Figs. 1–6 and Tables 1 and 2.

Discussion

In the present study, the mean age of the patients was 52.47 ± 14.75 years, about 86.6% of patients were above 40 years. This mean age group was found to be comparable
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Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6
with the mean ages of the patients in previous similar studies; which varied from 16.7 to 52.3 years [13–17].

All the patients in the present study were symptomatic at the time of referral. The main presenting symptom was dyspnea (100% of patients), while cough, chest pain and loss of weight were observed in 60%, 20% and 26.7% of cases respectively.

In pleural effusion, breathing at a higher than normal chest wall volume leads to making the inspiratory muscles operating with abnormally low gain in converting a given neural input into a mechanical output and respiratory discomfort would arise from the recognition that the volume displacement achieved is inappropriately small for the sense of effort made. The decrease in the volume of the chest cavity after removal of the pleural fluid is associated with a lengthening of the inspiratory muscles at the end of expiration, placing these muscles on a more advantageous portion of their length–tension curve and allowing them to generate more pressure for the same or lesser neural input [18]. The above data would provide an explanation for dyspnea and improvement of dyspnea observed in our studied cases following pleural fluid drainage. The mean amount of drained fluid during thoracoscopy was 1.8 ± 0.8 L with a maximum of 3 and a minimum of 0.5 L.

Whereas, presence of parenchymal affection of the lung especially in cases of interstitial lung disease or airway obstruction could be another contributing factors for dyspnea in our studied cases.

Regarding radiographic study, plain X-ray and computed tomography have been used in diagnosis of the studied cases. Computed tomography provides cross-sectional images, two-dimensional images that overcome the problems caused by super-imposition of anatomic structures seen with chest radiographs. It also permits a view of underlying parenchyma which may be obscured by the pleural disease [19].

Lung abnormalities with an increased density – also called opacities practically are divided into four patterns:

- Consolidation
- Interstitial
- Nodules or masses
- Atelectasis

In this regard, the role of chest CT include confirmation of the pulmonary origin of the nodule, number of nodules, location, size and determines its internal and edge characteristics, coexisting abnormalities, as well as evaluation of the best approach to biopsy [20]. With thin-slice chest-CT, the presence of a spiculated edge, also called a corona radiata, has a positive predictive value (PPV) range of 88–94% for malignancy, however, it may be seen in some benign lesions. A smooth contour, on the other hand, is suggestive of a benign nature of the lesion. However, up to a third of malignant nodules, especially metastatic lesions, may have smooth margins, therefore, the presence of a smooth contour is not a reliable sign. The presence of satellite lesions, tiny densities surrounding the primary nodule, is a characteristic feature of granulomatous disease and has a PPV of 90% for benign etiology. Administration of intravenous contrast may be necessary in certain situations to determine the enhancement of the nodule and/or to evaluate the mediastinum for the presence of lymphadenopathy [20].

Furthermore CT chest prior to thoracoscopy is essential; as detection of massive adhesions or complete lung collapse secondary to an endobronchial mass are considered contraindications to medical thoracoscopy [19,21,22]. Hence, thoracoscopy could then be performed after relief of endobronchial obstruction.

<table>
<thead>
<tr>
<th>Table 1 Prethoracoscopic evaluation of candidate patients.</th>
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<td><strong>Age (years)</strong></td>
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<td>≤50</td>
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<td>&gt;50</td>
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<td>Min.–Max.</td>
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<td>Mean ± SD</td>
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<td>Median</td>
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<td><strong>Smoking (pack year index)</strong></td>
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<td>Min.–Max.</td>
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<td>Mean ± SD</td>
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<td>Median</td>
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<td><strong>Sex</strong></td>
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<td>Female</td>
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<td><strong>Pleural effusion</strong></td>
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<tr>
<td><strong>Solitary parenchymal lesion</strong></td>
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<td>Right</td>
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<tr>
<td><strong>Diffuse pathology</strong></td>
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<td>Consolidation</td>
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<td>Nodules</td>
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<td>Mass</td>
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<td>Transthoracic needle biopsies before thoracoscopy</td>
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<td>Bronchoscopy before thoracoscopy</td>
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<th>Table 2 Results of thoracoscopy (findings, histopathology, complications).</th>
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<td><strong>Thoracoscopic findings</strong></td>
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<tr>
<td>Pleural effusion</td>
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<td>Visceral pleural affection</td>
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<td>Parietal pleural affection</td>
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<td>Mass (es)</td>
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<td>Nodules</td>
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<td>Plaques</td>
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<td>Adhesions</td>
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<td>Anthracosis</td>
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<td><strong>Histopathology</strong></td>
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<td>Metastases</td>
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<tr>
<td>BAC</td>
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<tr>
<td>Other types of bronchogenic Carcinoma</td>
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<tr>
<td>ILD</td>
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<tr>
<td>Inconclusive</td>
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<tr>
<td><strong>Complications</strong></td>
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<tr>
<td>Bronchopleural fistula</td>
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<tr>
<td>Surgical emphysema</td>
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<td>Wound infection</td>
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<td>Empyema</td>
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In this study, all patients having pleural effusion in chest HRCT, thoracoscopic examination revealed parietal pleural lesions in the term of plaques, nodules or masses. Hence these data signify that pleural involvement is possibly the responsible underlying cause of effusion in our studied cases. In this study, before resorting to medical thoracoscopy as a diagnostic tool, other diagnostic interventions were performed but their results were inconclusive. Fiberoptic bronchoscopy was done in three patients (20%), transthoracic ultrasound guided biopsy in three patients (20%), while both procedures were done in another three patients (20%). Negative results can be accused to that: some of these lesions were so peripheral, so they are out of reach of Fiberoptic bronchoscopy, interstitial lung lesions required a special type of bronchoscopic biopsy (transbronchial biopsy), or inadequacy of ultrasound guided transthoracic needle biopsies.

Preoperative evaluation is recommended since most complications can be avoided by proper selection of patients for thoracoscopy. Patients with severe chronic obstructive pulmonary disease and consequent respiratory insufficiency, with hypoxaemia (oxygen tension < 60 mmHg) and hypercapnia, will not tolerate induction of a pneumothorax without further deterioration of the gas exchange, and therefore are not suitable candidates for thoracoscopy. When there is a contralateral lung or pleural involvement, thoracoscopy is not advisable, unless general anaesthesia and tracheal intubation is used. Patients with an unstable cardiovascular status should not undergo thoracoscopy. Any patient with a history of cardiovascular disease should be evaluated by the cardiologist before thoracoscopy.

Also, the need for thoracoscopy should be considered carefully in severe pulmonary fibrosis as, after induction of a pneumothorax, it can be difficult to re-expand the lung due to the loss of elasticity of the pulmonary tissue. Pulmonary biopsy where honeycombing is present may result in prolonged leakage and impaired re-expansion of the lung. Pulmonary biopsy should be avoided in hydatid cysts, arteriovenous malformations and other highly vascularised lesions [13].

Regarding anaesthesia during medical thoracoscopy procedure, the procedure can be done under general or local anaesthesia as stated by the European Respiratory society (ERS) [14] depending on the indication and length of the procedure, the severity of illness of the patient, as well as on the experience of the physician and institutional biases. In our study, the procedure was performed under local anaesthesia and conscious sedation except in only one patient who received general anaesthesia because of the low pain threshold of the patient.

On the other hand, further studies used general anaesthesia during the procedure [16,23,24]. Although general anaesthesia facilitates application of the most available thoracoscopic interventions, yet it would increase patients risks related to cardiovascular complication [16,23,24]. Also, positive airway pressure during general anaesthesia can increase the risk of bronchopleural fistula. Possibly it is due to inadequate sealing of the cut surface of the visceral pleura by the electrocautery as a result of positive pressure.

Thoracoscopic findings in the studied group of patients demonstrated that the parietal pleura was affected in 6 (40%) patients showing nodules in 14 (93.3%) patients, plaques in 2 (13.3%) patients, and masses in 3 (20%) patients. Pleural effusion was traced in 6 (40%) patients, the mean amount of pleural fluid drained is 1.8 ± 0.8 L. Adhesions were found in 2 (13.3%) patients. The lung surface was affected in all 15 (100%) patients showing nodules in 14 (93.3%) patients, masses in 3 (20%) patients and anthracosis in 6 (40%) patients.

Concerning number and size of forceps lung biopsies that have been taken in the present study, a single biopsy was taken in 33.3% of patients, two biopsies in 53.3% of patients and three biopsies in 13.3% of patients. Inconclusive histopathological results were observed in cases with either single or two biopsies. The mean diameter of lung biopsies in our study was 3.68 ± 0.77 mm with a range of 2.1 mm–4.5 mm. Comparable results regarding biopsy size were observed in the study of Vansteenkiste et al. and Elnady et al. [25].

Vansteenkiste et al. (1999) performed medical rigid thoracoscopy in 24 patients with interstitial lung diseases. Three to ten lung biopsies were taken per patient, their mean diameter was 3.95 ± 1.23 mm [8].

The study of Elnady et al. (2012) aimed to demonstrate the safety, usefulness and feasibility of lung biopsy by medical thoracoscopy in patients with DPLDs on HRCT chest of unconfirmed diagnosis after evaluation with less invasive investigations. Ten patients with DPLDs of unknown etiology were included in their study, medical thoracoscopic lung biopsies were taken and sent for histopathologic examination. They demonstrated that good biopsy specimens were obtained in all patients with average size of biopsies of 0.5 ± 0.4 cm [25].

Whereas, Emam et al. (2012) performed experimental animal study to compare gross and microscopic features of deep and subpleural pleuroscopic lung biopsy samples. The mean number of biopsies taken per animal was 4.5 ± 1.22 and 4.83 ± 1.33 (p = 0.36) for deep and subpleural biopsies, respectively. The mean size of deep and subpleural biopsies was 1.758 ± 0.478 and 1.283 ± 0.851 cm², respectively [26].

Difference between our study and those of others [8,26] could be due to the differences regarding types of the studied patients, technique of the biopsy procedure and experience. This work is considered to be the first attempt to perform medical thoracoscopic lung biopsy in our department. To our knowledge, in the literature only few studies have reported experience in this field.

During the thoracoscopic procedure, biopsies were taken from the lung as well as from both lung and observed pleural lesions in some of our studied cases (Case Nos. 1, 5, 7, 9, 10, 15). Pleural biopsies were also subjected to histopathological study.

As regard the histopathological diagnosis of lung biopsies in our study. Five cases (33.3%) were diagnosed as malignant deposits. Two (13.3%) patients with bronchioloalveolar carcinoma. Two (13.3%) patients had other types of bronchogenic carcinoma. One of them had adenocarcinoma and the other one had small cell lung cancer. Three (20%) cases showed interstitial lung disease, two of them had cryptocogenic organizing pneumonia and a single case had desquamative interstitial pneumonia while, three (20%) cases demonstrated inconclusive results.

In addition, histopathological study of the pleural biopsies that revealed similar pathology to that of lung biopsies in cases 1, 9, 10 demonstrated bronchogenic carcinoma signifying that these pleural lesions were metastatic deposits, while cases 5, 7, 15 showed pleural deposits of extrapulmonary...
malignancy but also with the same histopathology of lung biopsies.

Vansteenkiste et al. (1999) performed thoracoscopic lung biopsy for 24 patients with interstitial lung disease. They found Pneumocystis carinii pneumonia, sarcoidosis, amyloidosis, hypersensitivity pneumonitis, obliterated small arteries and COP one patient for each. Two patients had lymphangitic carcinomatosis, three patients had UIP, two patients had DIP and two had LIP. A single patient showed normal lung parenchyma out of 24 patients [8].

Krasna et al. (1995) performed VATS for twenty-four patients with suspected interstitial lung diseases using a double lumen tube and stapler technique for taking wedge shaped biopsies. The pathologic findings for the resected specimens were as follows: UIP seven patients, granulomas four patients, Wegner’s granulomatosis three patients, BOOP two patients, CMV pneumonia and LAM single patient for each [27].

Compared to the above studies, in this work different radiological varieties were included (nodules, masses, interstitial lung disease) versus only interstitial lung diseases in the other studies [8,27]. This selection allows to study the validity of thoracoscopic lung biopsies in the different radiological and pathological lesions.

Results of this study provide evidence for the efficiency of thoracoscopic lung biopsies in the diagnosis of different pulmonary pathological lesions.

In our study, few complications were encountered in the studied group of patients. Local wound infection was observed in one patient (6.7%) and he was managed by frequent sterile dressings, local antiseptic solution and local antibiotics, and all cases resolved within 4–5 days. Subcutaneous emphysema was encountered in 2 patients (16.4%) and resolved 1–2 days after the procedure.

Compared to our results, Elnady et al. in their study of lung biopsy by medical thoracotomy in patients with DPLDs reported persistent air leak for 5 and 7 days, pneumothorax after removal of the intercostal tube, pain and minor bleeding in 20%, 20%, 60% and 10% of patients respectively. They concluded that the procedure is feasible and safe. It carries some complications that are not life threatening and can be minimized by a good selection of patients [23,7].

Prolonged air leak for more than 5 days was observed in only one patient (6.7%) (Case No. 4). The air leak was not related to number or size of biopsies, but it might be related to positive pressure used during the general anaesthesia. Instillation of saline over the sites of biopsy taking helped us greatly to detect air leak at these sites and so allowed the use of extra-coagulation after sampling. These intra-operative techniques greatly help to decrease the incidence of air leak at sites of biopsy sampling.

Compared to our results, in the study of Boutin et al. [28] who performed medical thoracoscopic lung biopsies incases with interstitial lung disease, a prolonged air-leak (> 5 days) was noted in three out (15%) of 20 patients with stiff lungs and fibrosis.

Whereas, Vansteenkiste et al. (1999) reported it in seven patients (27%) out of 24 patients [8]. In the study of Dijkman et al. [6], the mean duration of drainage was 4.5 days (maximum 14) also in cases of interstitial lung disease using medical thoracotomy.

Randall et al. reported that it is difficult to summarize the overall complication rate because it depends on the indication of thoracotomy, type of anaesthesia, equipment used, patient population, experience of the operator and adequacy of post procedure care. These factors can explain the wide range of variation in the reported incidence of post-thoracoscopic complications [29].

Among factors that may contribute to persistent alveolar air leaks [30] are the presence of preoperative risk factors (increased age, male gender, COPD, steroid use, infections, adhesions, apposition of pleura and lung surface) operative techniques to reduce air leak, staple lines, handling of tissues, and postoperative factors (chest tube management, and high ventilation pressures).

In the present study, none of the studied case patients developed empyema. The reported incidence of empyema in the previous thoracoscopic studies varied from 0% in multiple studies [15,31–34], 0.5% (5 of 1145 cases) [35], 0.6% (1 of 147 cases) [36], 1% (6 of 556 cases) [37], 2% (4 of 182 cases) [29], 2.5% (9 of 360 cases) [38], 4% (6 of 149 cases) [13], 4.8% (2 of 42 cases) [39] to 10% (3 of 30 cases) [40]. The difference in the incidence of empyema in the different studies may be related to the number of cases in each study (mostly noted that higher incidence of empyema was recorded with studies performed on a fewer number of cases), the adequacy of disinfection of the field of the procedure, the underlying cause of pleural effusion, the availability of adequate antibiotic for an adequate duration and the general condition of the patients.

In this study, one patient developed local wound infection at the site of insertion of the intercostal tube. The incidence of local wound infection was reported following thoracoscopy in previous studies varied from 0% [34,41], 0.5% [35], 1% [29], 1.5% [31], 7.1% (3 of 42 cases) [39] to 43.33% [40]. Local wound infection is a small self limiting complication. It requires local application of antiseptics and frequent dressing changes. This could explain such a widely reported range of incidence. Many operators would not bother to report it.

In the present study, two (16.4%) patients developed surgical emphysema which may be due to wide pleural opening. The incidence of surgical emphysema was reported following thoracoscopy in previous studies varying from 1.5% [31], 2% [43], 4% [42], 5.3% [13], 7% [44], 7.1% [39], 7.01% [37], 8% [29], 8.33% [14], 10% [34], 20% [15] to 23.33% [40] patients. This difference in the incidence of surgical emphysema may be related to size of the wound, tightness of the sutures and experience of the operator. It is usually minimal in amount and self limiting. Again, it is one of the minor complications which could be easily ignored by the operator [36,45,46].

Conclusions

Preoperative evaluation and proper selection of patient candidates for medical thoracoscopy should be an integral part of the procedure since this can avoid most of the complications. It is convenient to perform medical thoracoscopy under local anaesthesia and conscious sedation. Proper intraoperative precautions contributed significantly in minimizing thoracoscopy related complications. Our results provide circumstantial evidence for the safety and efficiency of thoracoscopic forceps Lung biopsy in the diagnosis of different lung lesions (diffuse lung disease as well as localized lung lesions extending to peripheral lung regions).
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Conflicts of interest

None.

References


