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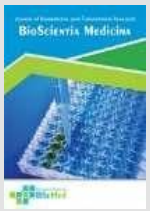

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Flexi-rigid Pleuroscopy in Diagnostics of Malignancy: A Narrative Literature Review

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A B S T R A C T

Pleuroscopy is a less invasive treatment that allows access to the pleural cavity with the use of both visual and surgical equipment. This technique can be conducted with local anesthesia and mild sedation. Pleuroscopy is a medical procedure used for both diagnosis and treatment in the pleural cavity. Pleuroscopy enables direct observation of the pleural surface, enhancing the safety of procedures such as pleural biopsy, pleural fluid drainage, and pleurodesis. One purpose is to assist in verifying the diagnosis of cancer. This review was aimed to describe the use of flexi-rigid pleuroscopy in malignancy.

1. Introduction

Pleuroscopy, also referred to as thoracoscopy, has been recognized as such since 1923. Hans Christian Jacobaeus pioneered the technique of pleuroscopy, also known as medical thoracoscopy, between 1910 and 1930. Jacobaeus is credited with pioneering the pleuroscopy technique, earning him the title of the father of thoracoscopy.[1] The global annual incidence of pleural illness exceeds 300 cases per 100,000 individuals. The diagnosis of pleural disease can typically be confirmed using a combination of historical information, physical examination, and investigation of pleural fluid. Approximately 26% of pleural effusions remain undetected and necessitate additional investigation.[1,2]

The abnormal buildup of fluid in the pleural cavity, known as pleural effusion, can result from either an increase in fluid production or a decrease in fluid absorption. Pleuroscopy is necessary when pleural effusion cannot be detected using thoracentesis-based pleural fluid analysis. The sensitivity seen in certain pleuroscopy investigations has ranged from 93% to 97%, while a closed pleural biopsy has demonstrated a sensitivity of 40%. Malignant pleural effusion is a condition with an overall unfavorable prognosis. The median survival rate following the diagnosis of malignant pleural effusion is approximately 6 months. Pleuroscopy, closed pleural biopsy, ultrasound-guided pleural biopsy, and thoracentesis are just a few of the interventional techniques that can diagnose malignant pleural effusion. Pleuroscopy is a medical treatment that necessitates coordination among many medical professions.[2,3]

Pleuroscopy is a less intrusive procedure used to

access the pleural cavity, allowing for direct observation of the pleural surface. This technique can be conducted using a local anesthetic or with mild sedation. Pleuroscopy is a medical treatment that is used to diagnose and treat conditions in the pleural cavity. It is known for its high level of accuracy in diagnosing medical conditions. Pleuroscopy facilitates the direct observation of the pleural surface, hence enhancing the safety of pleural biopsy and pleurodesis procedures. Pleuroscopy plays a crucial role in verifying the diagnosis of cancer.[4,5] The objective of this literature review is to provide a comprehensive description of pleuroscopy procedures specifically for the diagnosis and treatment of malignancies.

Flexi-rigid pleuroscopy

A disposable flexible trocar is inserted through a single 1–2 cm skin incision to serve as the entry point for the flexi-rigid pleuroscope in flexi-rigid pleuroscopy. The rigid flexi pleuroscopes, namely the LTF 160 or 240 models of Olympus, have a design and handling that closely resemble bronchoscopes. This similarity enables the performance of pleuroscopes in a manner comparable to flexible bronchoscopes. The rigid flexi pleuroscope is composed of a handle and shaft with dimensions of 7 mm in outer diameter and 27 cm in length. The shaft comprises a 22-cm hard proximal section and a 5-cm flexible distal segment. The tip's flexibility can be adjusted using a lever on the handle, enabling angulation in two directions: up to 160 degrees and down to 130 degrees.[6-10]

This pleuroscope model features a 2.8-mm-diameter working channel that is suitable for use with a spray catheter, diathermic knife, and cryoprobe. These instruments are valuable for performing a range of procedures, including obtaining tissue samples for diagnosing pleural conditions such as malignancy or infection.[11-13] Flexi-rigid pleuroscopy offers the benefit of using the same manufacturer's processor and light source (LTF 160 and LTF 240) as flexible bronchoscopes or gastrointestinal endoscopes. This means that these components are readily available in most endoscope units without incurring any extra costs, as depicted in figure 1.[1,9,13]

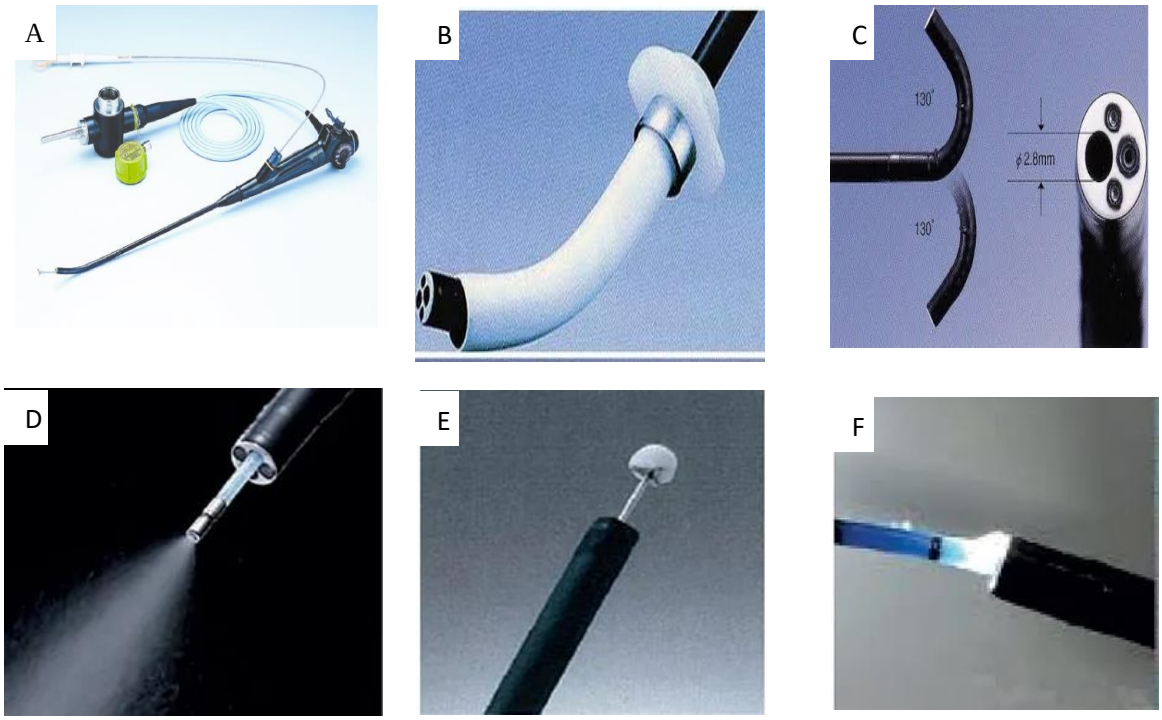


Figure 1. Flexi-rigid pleuroscopy; (A) Flexi-rigid pleuroscopy; (B) Working channel; (C) Working channel diameter; (D) Spray catheter; (E) Diathermic knife; (F) Cryoprobe.

Ishhi et al. utilized the latest flexible flexi-rigid pleuroscope, specifically the LTF-Y0032, which offers the advantage of a 180-degree viewing angle for the camera, both upwards and downwards. In contrast, the LTF-240 pleuroscope can only provide a viewing angle of 160 degrees upwards and 130 degrees downwards. The researchers tested the LTF-Y0032 pleuroscopy and forceps biopsy. They then did a histopathological examination, which showed that the patients had mesothelioma. Figure 2 presents a comparison between the LTF-Y0032 and LTF-240 pleuroscopy, as well as the visualization obtained through pleuroscopy.[14]

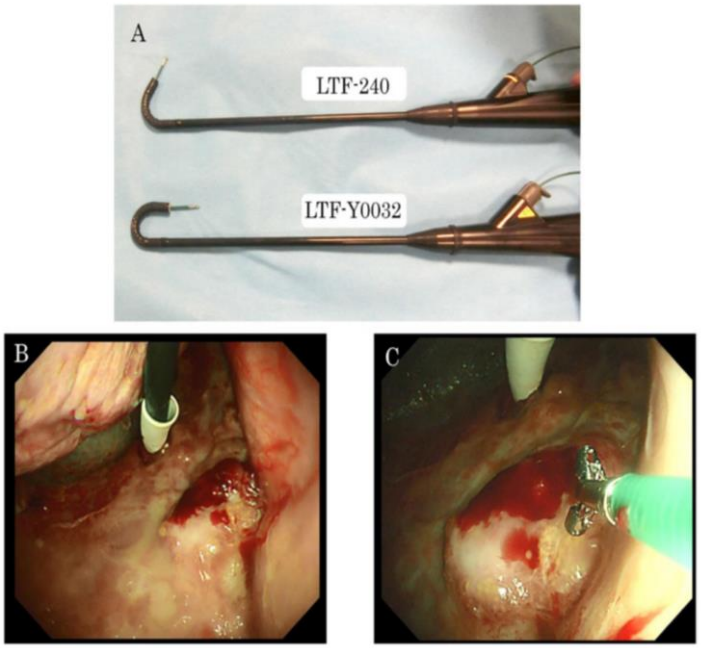


Figure 2. (A) Comparison of LTF-240 and LTF-Y0032; (B) Visualization of LTF-Y0032; (C) Cryobiopsy.

Pleuroscopy procedure

Effective preparation is crucial for successful pleuroscopy, encompassing patient preparation, meticulous technique execution, and anticipation of potential complications. These measures are essential to ensuring optimal diagnostic and therapeutic outcomes for the patient. Pleuroscopy is performed mostly in individuals who have had prior diagnostic procedures, but the etiology remains unidentified. During pleuroscopy, particularly when there is a suspicion of malignancy, a sample can be obtained using forceps and subsequently subjected to histological investigation. The pleuroscopy procedure can be described as follows.[15]

Patient preparation

Prior to the pleuroscopy operation, it is necessary to obtain informed permission from the patient. The patient should also receive education about the aim of the treatment as well as the potential issues that may arise during the pleuroscopy. Prior to this, a comprehensive medical history and physical examination of the patient were conducted, along with laboratory tests. Chest x-rays, ultrasounds, and computed tomography (CT) of the chest are conducted to aid in determining the optimal site for pleuroscope insertion. The purposeful creation of a pneumothorax prior to pleuroscopy using a thoracentesis catheter causes the lung to collapse away from the chest wall and creates a suitable area for trocar insertion.[2]

Anesthesia procedure

Pleuroscopy is typically conducted using local anesthetic and mild sedation, which patients generally handle well. The term conscious sedation, as commonly used in literature, denotes the state in

which patients stay aware throughout a medical treatment while receiving modest anxiolytics and pain medicine. Conscious sedation eliminates the need for an anesthesiologist and can result in a cost reduction. General anesthesia is recommended in some cases, such as when patients have allergies to local anesthetics, when patients are agitated and uncooperative, and while administering anesthesia to pediatric patients.[1,14]

Technique

The technique is performed with the patient positioned in the lateral decubitus posture, laying on the side opposite to the affected area. Identify the specific location where one can enter the body, specifically at the middle point of the axillary line, between the fourth and fifth spaces between the ribs. It is recommended to access tumor metastases or diffuse malignant mesothelioma from the fifth to seventh intercostal space. These are usually found in the inferior costovertebral angle and diaphragmatic surface. Depending on the clinical context and diagnostic imaging techniques such as thoracic radiography, thoracic CT, and ultrasound, alternative entry sites may be utilized in exceptional circumstances. In cases of suspected anterior or superior blebs, the two to three anterior intercostal spaces are selected for pneumothorax treatment.[15]

Propofol and midazolam are frequently administered for sedation, in addition to opioids for pain relief, prior to pleuroscopy. The optimal protocol for pleuroscopy is to position the patient in the lateral decubitus posture with the operation site oriented in an upward direction. Perform an ultrasonic examination of the pleural cavity, commencing at the 5th or 6th intercostal space in the midaxillary line. In the presence of adhesions, relocate to the neighboring region. After identifying the entry point, administer local anesthesia to the patient using 1% lidocaine with the assistance of ultrasound guidance.[15,16] Ensure to observe whether lidocaine has penetrated the subcutaneous space, muscle layer, and parietal pleura.

The trocar is introduced into the pleural cavity using its blunt end. A pneumothorax is induced in some instances where there is an absence of a pleural cavity with a volume of at least 100–200 ml, or around 2-4 cm in depth. This permits the ingress of air into the pleural cavity, resulting in the formation of an artificial pneumothorax and subsequent collapse of the lung. This step is omitted in patients with severe pleural effusions. A careful dissection using artery forceps follows the creation of a small, 1-2 cm incision. This dissection is performed via the subcutaneous tissue, intercostal muscles, and finally into the pleural cavity. Subsequently, an expendable 8-mm trocar is introduced into the pleural cavity to facilitate the passage of the pleuroscope.[17]

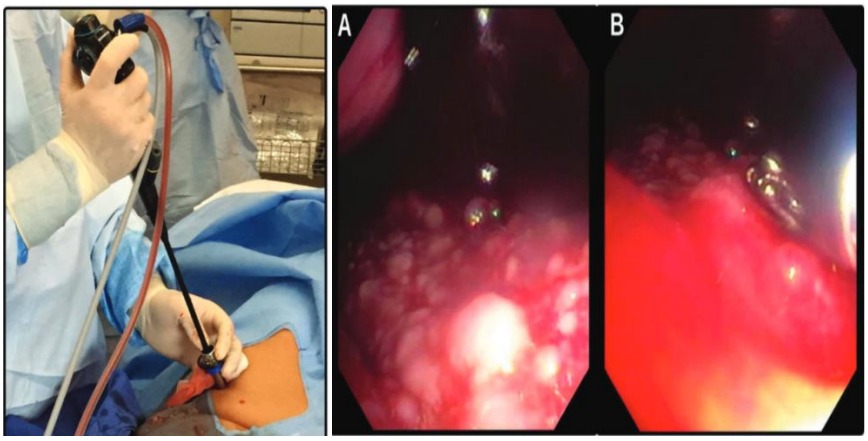


Figure 3. Visualization of the pleuroscopy procedure; (A) multiple pleural density during the pleuroscopy procedure; (B) core pleural biopsy.

The pleural cavity is inspected, and 6–8 biopsies are obtained using forceps, employing a lift and peel method. Following the surgery, a 10–14 Fr pigtail catheter is inserted into the pleural cavity to facilitate the removal of the pneumothorax. In contrast, if the intention is to insert an indwelling pleural catheter (IPC) for extended drainage purposes, the same IPC can also facilitate the release of air. Following the procedure, a mobile chest x-ray is conducted. Once the lungs have fully expanded, the pigtail catheter can be extracted. The process of pleuroscopy can be observed in Figure 3.[17,18]

Pleuroscopic-guided biopsy of the parietal pleura

The integration of electrocautery with rigid flexi forceps biopsy has enhanced the outcomes. A diathermic knife can be used during flexi-rigid pleuroscopy to obtain a full-thickness parietal pleural biopsy. According to a study, the diagnostic yield was 85% when using a diathermic knife, whereas it was 60% when using stiff flexion forceps. Diathermic blades are quite beneficial for treating thicker lesions in cases of malignant mesothelioma. However, the effectiveness of this procedure in obtaining samples depends on the operator's level of expertise.[21,22]

Pleuroscopy in the diagnosis of malignancy

The sensitivity of pleuroscopy in patients with malignant pleural effusion ranges from 92% to 97%, while its specificity ranges from 99% to 100%. A study conducted by Martenson et al. examined 334 individuals who had unexplained pleural effusion and underwent pleuroscopy. The results showed that malignancy was discovered in 79% of the instances. Jansen et al. conducted a study involving 208 patients who had pleuroscopy. The study revealed that 55% of the patients were identified with malignant pleural effusion. Pleuroscopy is a highly effective method for assessing diseases of the pleura and lungs. Pleuroscopy demonstrates a high level of accuracy in the diagnosis of malignancy. Additionally, it exhibits a favorable safety profile with low overall complication rates ranging from 1-5% and a case fatality rate of 0.8%.[23,24]

Pleuroscopy in malignant pleural mesothelioma

Malignant pleural mesothelioma is an incurable cancer that affects the surface of the pleura. The median survival rate for individuals diagnosed with malignant pleural mesothelioma ranges from 6 to 18 months, with respiratory failure being a common cause of death. Malignant pleural mesothelioma develops in individuals who have been previously exposed to asbestos. Confirming a diagnosis with pleural fluid cytology and a closed needle biopsy is challenging, which is why some medical professionals suggest performing an open biopsy or pleuroscopy to get abundant samples for histological evaluation.[24] Helen et al. conducted a study on a total of 507 patients by analyzing samples of pleural fluid cytology. If the mesothelin level is above 2 nmol/L and the megakaryocyte potentiation factor (FPM) level is above 12.4 ng/mL, this test can diagnose malignant pleural mesothelioma 65% of the time and 95% of the time. Pleuroscopy is the preferable method over thoracotomy due to its minimally invasive nature, which allows for a sample. However, it is important to examine the adequacy of tissue collected with stiff flexi forceps. In cases where mesothelioma is suspected, the use of a diathermic knife for a biopsy is suggested.[18,24,25]

Clinical symptoms of malignant pleural mesothelioma

The onset of mesothelioma occurs gradually, typically manifesting symptoms after a period of 20 to 60 years. Malignant pleural mesothelioma presents symptoms including dyspnea, thoracic discomfort, and a productive cough. The usual overall survival for malignant pleural mesothelioma is 6–18 months from the time of diagnosis, with less than 10% of patients surviving for 5 years. However, individuals who get multimodal treatment have shown a median survival of 13–23 months. Female gender, younger age at diagnosis, earlier clinical stage, absence of lymph node involvement, and lower comorbidity scores were all

factors that correlated with longer survival. Mesothelioma is a malignancy characterized by its aggressive nature and low prevalence. Thoracic CT scans revealed a direct correlation between the clinical factors that were associated with shorter survival and the degree of mesothelioma and the size of the tumor. Elevated serum lactate dehydrogenase, a neutrophil-to-lymphocyte ratio greater than 5, anemia, and malnutrition are laboratory findings that can exacerbate the patient's clinical state. The histological type is a very important factor in figuring out the prognosis, and nonepithelioid malignant mesothelioma has a shorter survival time than epithelioid mesothelioma.[26]

Types of malignant pleural mesothelioma

The different types of malignant pleural mesothelioma are based on the type of cells that make up the tumor. These types are epithelioid tumors, sarcomatoid tumors, and biphasic tumors. The epithelioid subtype is the predominant form of malignant pleural mesothelioma. The study conducted by Zhang et al. determined that among patients with malignant pleural mesothelioma, the prevalence of the epithelioid type was 61.5%, the biphasic type was 22%, and the sarcomatoid type was 16.4%. The results were acquired via forceps biopsy and surgical resection, and they exhibited an 80.6% concordance with the anticipated outcomes. According to the biopsy results, biphasic and epithelioid histology had the strongest connection.[22-28] Epithelioid malignant pleural mesothelioma exhibits the most favorable prognosis. The epithelioid type can exhibit different morphologies, including the solid type (44%), tubulopapillary type (29%), micropapillary type (13%), tubular type (7%), and trabecular type (2%). When looking at a tissue section, the sarcomatoid type of malignant pleural mesothelioma is identified by cells that are shaped like spindles and have a lot of cytoplasm. Distinguishing sarcomatoid-type malignant pleural mesothelioma from pleurisy can be challenging based on histology alone. Therefore, an immunohistochemical examination is necessary to differentiate between these conditions. Sarcomatoid cancers exhibit poor survival rates. Figure 4 displays the histology of malignant pleural mesothelioma.[6,26-29]

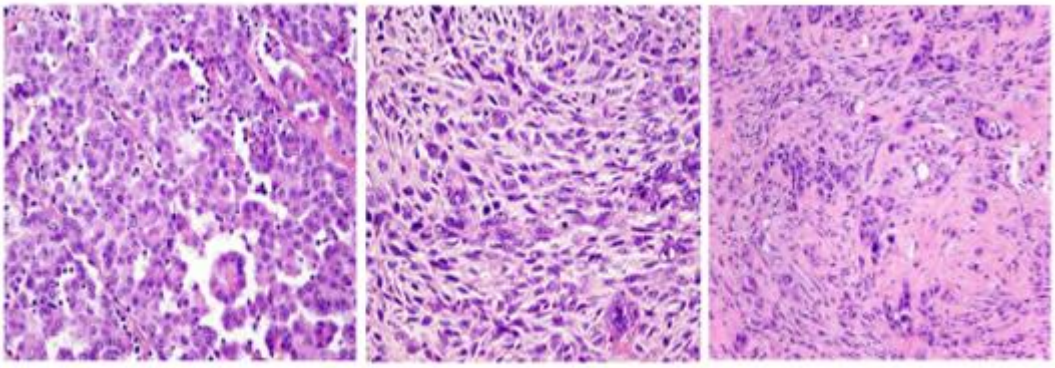


Figure 4. Histology of malignant mesothelioma; (a) Malignant pleural mesothelioma epithelioid type; (b) Malignant pleural mesothelioma biphasic type; (c) Malignant pleural mesothelioma sarcomatoid type.

The pleuroscopy procedure for malignant pleural mesothelioma involves positioning the patient in the lateral decubitus position with the procedure site facing upwards. The location for trocar installation is determined to be in the mid-axillary line, specifically in the fourth to fifth intercostal space. Anesthesia is administered using lidocaine, which is infiltrated into the subcutaneous, muscle layer, and parietal pleura. After making a 1-2 cm incision, a blunt dissection using arterial forceps follows. An 8-mm trocar is then inserted into the pleural space to allow passage of the pleuroscope. The pleural cavity is explored, and 6 to 8

biopsies are taken using forceps, employing the "lift and peel technique" principle if necessary. Complications such as pneumothorax may necessitate the insertion of a chest tube or interventional pulmonary catheter (IPC). Assuming no issues arise, the surgery is concluded by applying sterile gauze to the incision site. Figure 5 displays an instance of pleuroscopy being used in the context of malignant mesothelioma.[19,20]

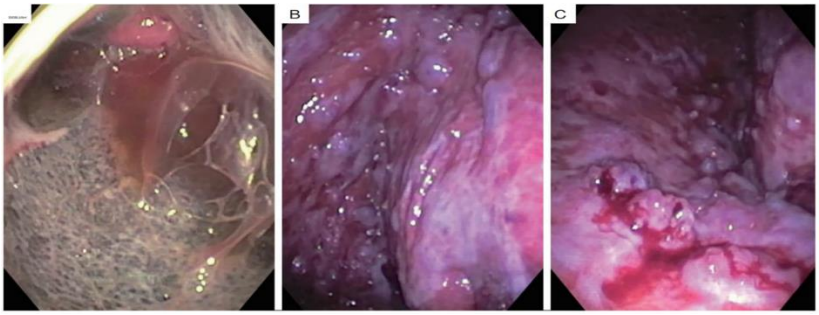


Figure 5. Pleuroscopy uses rigid flexion; (A) Image taken immediately after entering the pleural cavity in a patient with mesothelioma; (B) Visualization of malignant pleural mesothelioma; (C) Minimal bleeding after cryobiopsy.

Pleuroscopy in lung cancer

In lung cancer, pleural effusion can be caused by the tumor spreading through the blood or lymph, the tumor embolism going to the visceral and parietal pleura, or the tumor spreading through the blood or lymph. In order to determine the stage of this type of lung cancer, it is necessary to do an immunohistochemical analysis of the visceral pleural layer. This is because the invasion of the visceral pleural layer is regarded as an important factor in staging when there is no involvement of the lymph nodes.[21] Pleural metastasis, which refers to the spread of lung cancer to the pleura, significantly reduces survival rates. In the current staging system for lung cancer, pleural metastasis is categorized as M1a. Patients with lung cancer who have exudative pleural effusion and negative cytology examination results are eligible for pleuroscopy. Pleuroscopy is conducted to ascertain the origin of the pleural effusion, whether it arises from a primary tumor in the pleura or metastases from the lung, through the collection of samples. The pleuroscopy process is identical to the one used for mesothelioma. If metastases are detected in the pleura through histological and immunohistochemical analysis, the condition is categorized as stage IV. However, if just the cytology results show positive findings, it is classified as stage IIIB.[24-26] The pleuroscopy procedure conducted on the patient with lung cancer revealed the presence of a tumor that exhibits a high susceptibility to bleeding. This observation is visually depicted in Figure 6.

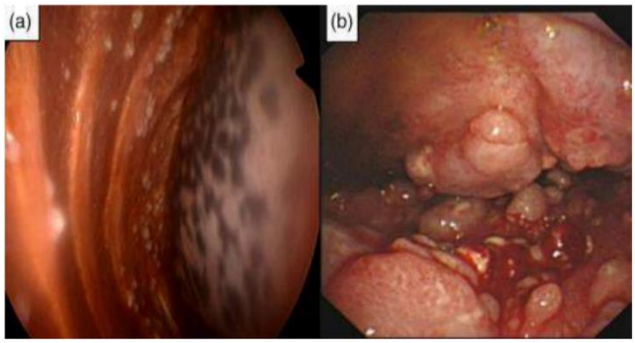
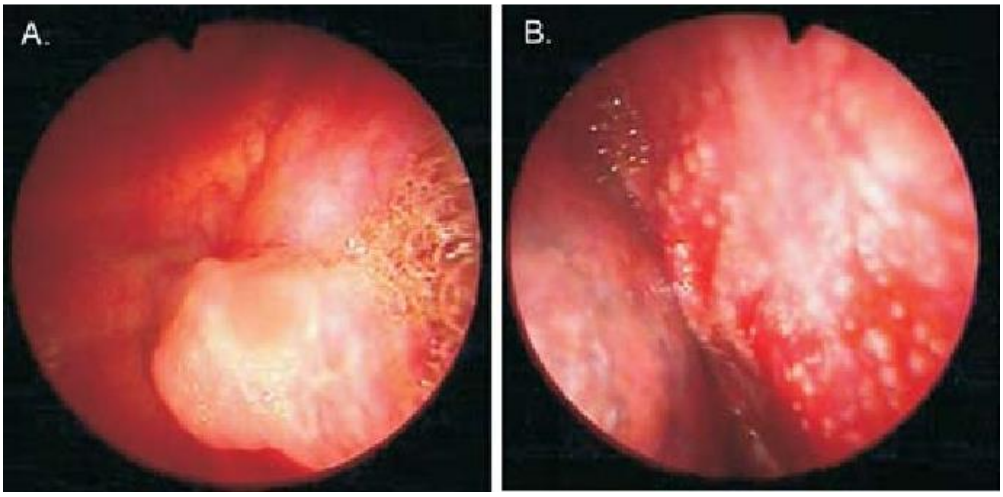


Figure 6. Pleuroscopy in lung cancer

Pleuroscopy on malignant pleural effusion

The discovery of cancerous cells in the fluid or tissue removed from the pleura confirms the presence of malignant pleural effusion, which is fluid in the pleural space that is associated with cancer. When there is a clinically detectable malignancy that manifests as hemorrhagic or serohemorrhagic exudate fluid, malignant pleural effusion may develop. This fluid is often abundant and continues to accumulate even after thoracentesis, a procedure used to drain intrapleural fluid and reduce its volume. Plaque-like fluid builds up in the pleura because blood vessels become more permeable because of swelling caused by cancer cells spreading in either the parietal or visceral pleura. Occasionally, a primary tumor cannot be detected in the lung or in any other location outside the lung. In such instances, the malignant pleural effusion is attributed to a lung tumor.[27] In people who have recurrent malignant pleural effusion, treatment therapies like pleurodesis can be done at the same time as pleuroscopy procedures. Pleurodesis has a success rate that can reach up to 90%. When carried out by a skilled operator, pleuroscopy is a safe procedure that produces excellent therapeutic results and high levels of diagnostic accuracy. Pleuroscopy is used to identify the origin of pleural effusion when it is unknown, assess the stage of lung cancer, and carry out pleurodesis.

Pleuroscopy can be conducted either in the operating room or in a standard procedural room. Pleuroscopy can be conducted using a local anesthetic.[27] Pleuroscopy for malignant pleural effusion can be conducted with the patient positioned laterally, with one half of the chest looking upwards. To make sure that the abnormality is seen correctly, the pleuroscope entry into the pleural cavity can be moved around based on the results of the preoperative x-rays and physical exam. Prior to local anesthetic infiltration, aseptic and antiseptic procedures are performed on the skin. Following the administration of anesthetic, the trocar is placed into the hemithorax, and subsequently, the pleuroscope is inserted. A pleuroscope is placed into the pleural cavity to provide a clear view of the whole cavity, after which pleural fluid evacuation, biopsy, and pleurodesis are performed.[28,29] The pleural fluid is removed using a suction tube, and a pleural biopsy is performed using biopsy forceps. Following the completion of the procedure, the pleuroscope is extracted and a chest tube is introduced to reinflate the lung. Adverse outcomes associated with pleuroscopy are infrequent. Possible complications include hemorrhaging, infection, damage to organs within the chest, and recurrent esophageal perforation. Following the surgery, a water seal drainage (WSD) assessment is conducted to monitor the advancement of the patient's condition.[29] Figure 7 displays the pleuroscopy image of a malignant pleural effusion.



Gambar 7. Pleuroscopy on malignant pleural effusion.

2. Conclusion

Pleuroscopy is a minimally invasive procedure to access the pleural cavity using a combination of visual and surgical instruments. Pleuroscopy aims for diagnostic and therapeutic procedures in the pleural cavity. Pleuroscopy in malignancies is a diagnostic aid with rare complications.

3. References

1. Rasmin M, Jusuf A, Amin M, Taufik, Naws M, Yunus F, et al. Buku ajar pulmonologi dan kedokteran respirasi: Pleuroskopi. Universitas Indonesia, Jakarta. 2017:p.423-30.
2. Izumo T, Sasada S, Aso T, Nasu K, Arai Y. Respiratory Endoscopy. Springer, Singapore. 2017:p.183-92.
3. Panadero F. Pleuroscopy or video-assisted thoracoscopic surgery for exudative pleural effusion: a comparative overview. Elsevier. 2019;51:177-84.
4. Wahidi M, Ost D. Practical guide to interventional pulmonology. Elsevier, Philadelphia. 2022:p.179-88.
5. Ernst A, Herth F. Principles and practice of interventional pulmonology.. Springer, New York. 2020:p.665-73.
6. Ravindranath K, Sriprkash K. Dissection manual with region and applied anatomy. Jaypee, London. 2018:p.117-81.
7. Lee P. Thoracoscopy. ERS, United Kingdom. 2017:p.176-88.
8. Michaud G, Berkowitz D, Ernst A. Pleuroscopy for diagnosis and therapy for pleural effusions. Chest. 2018;10:1242-6.
9. Robinson B. Malignant pleural mesothelioma: an epidemiological perspective. AME. 2019;4:491-6.
10. Anna C, Bibby, Selina T, Nikolaos K, Hannah B, Denis C, et al. Malignant pleural mesothelioma: an update investigation, diagnosis and treatment. ERS. 2020;25:472-86.
11. Coenraad F, Jane A, Elvis M, Irusen, Gary L. Contemporary best practice in the management of malignant pleural effusion. Sagepub. 2018;12:1-13.
12. Ishii S, Ishii Y, Kaburagi T, Nakano T. Usefulness of new flex-rigid pleuroscopy in the diagnosis of malignant pleural mesothelioma. BMJ Case Rep.2019;12:1-2.
13. Dutt T, Touseheed S, Mohan M. Diagnostic and therapeutic pleuroscopy using a flexible fiberoptic bronchoscope for resource-poor environments: a case series. Dept Pulmonary Canada.2017;59:173-6.
14. Jain S, Wallen J. Malignant mesothelioma early detection, diagnosis, and staging. American Cancer Society.2018;1-22.
15. Wadow B, Hung Y. Malignant pleural mesothelioma subtypes. Atlas.2019;10:373-8.
16. Anevlavis S, Froudarakis M. Advance In Pleuroscopy. Clin Respir J. 2018;12:839-847.
17. Martenson K, kao S, Lee K, Takashi K, Linyon A. The minimum standard of care for managing malignant pleural mesothelioma in developing nations within the Asia-Pacific Region. Wiley. 2021;1:1-14.
18. Ali M, Light R, Maldonado F. Pleuroscopy or video-assisted thoracoscopic surgery for exudative pleural effusion: a comparative overview. J Thoracic Dis. 2019;11:3207-16.
19. Vial M, Eapen G, Casal F. Combined pleuroscopy and endobronchial ultrasound for diagnosis andstaging of suspected lung cancer. Elsevier. 2018;23:49-51.
20. Manharan A, Argaez C. Pleuroscopy for the diagnosis of cancer in patients with pleural effusion: a review of the diagnostic accuracy, safety, cost-effectiveness and guidelines. CADTH. 2020;12:3-43.
21. Zhang Y, Gu Y, Lizhu Y, Liu X, Zhang S. Clinical, laboratory, histological, radiological, and metabolic features and prognosis of malignant pleural mesothelioma. Medicina. 2022;58:1-21.
22. Prakash A, Jaiswal A, Jain R, Datta B.

Interventional pulmonology and issues related to the lung surgery. Lung India. 2022;39:159-71.

23. Jansen M, Davidson K, Dash R, Jug R, Clarke J, et al. Pleural effusions associated with squamous cell lung carcinoma have a low diagnostic yield and a poor prognosis. Orcid. 2021;6:2500-8.
24. Ishii S, Watanabe H, Suzuki M, Hashimoto M, Likura M, et al. Evaluation of the efficacy and safety of a new flex-rigid pleuroscope. Wiley. 2021;15:91-6.
25. See K, Lee P. Advances in the diagnosis of pleural disease in lung cancer. Therapeutic Advances in Respiratory Disease. 2019;6:409-18.
26. Li D, Jackson K, Panchal R, Aujayeb A. Local anaesthetic thoracoscopy for pleural effusion-a narrative review. Healthcare. 2022;10:1-9.
27. Addala D, Kanellakis N, Baedawi E, Dong T, Rahman N. Malignant pleural effusion: Updates in diagnosis, management and current challenges. Frontiers. 2022;12:1-9.
28. Putra C, Setyawan U, Putra N. Case report: management of thoracic empyema with pleuroscopy in lung cancer patient. MRJ. 2022;4:210-5.
29. Chantharakhit C, Sujaritvanichpong N. Developing a prediction score for the diagnosis of malignant pleural effusion: MPE Score. Asian Pacific J Cancer Prevent. 2022;23:25-31.