JCS Journal of Chest Surgery
https://doi.org/10.5090/jcs.22.063
pISSN: 2765-1606 eISSN: 2765-1614
J Chest Surg. 2023;56(1):1-5

Clinical Research

Video-Assisted Thoracic Surgery Core Needle Biopsy for Pulmonary Nodules in Patients with Impaired Lung Function: Is It Feasible and Safe?

Yong-Seong Lee, M.D., Jong Duk Kim, M.D., Hyun-Oh Park, M.D., Chung-Eun Lee, Ph.D., In-Seok Jang, Ph.D., Jun-Young Choi, Ph.D.

Department of Cardiothoracic Surgery, Gyeongsang National University Hospital, Gyeongsang National University College of Medicine, Jinju, Korea

ARTICLE INFO
Received July 14, 2022
Revised October 10, 2022
Accepted October 18, 2022

Corresponding author
Jong Duk Kim
Tel 82-55-750-8000
Fax 82-55-753-8138
E-mail frogeye1@gnuh.co.kr
ORCID
https://orcid.org/0000-0003-0268-1674

Background: The number of patients with incidentally identified pulmonary nodules is increasing. This study attempted to confirm the usefulness and safety of video-assisted thoracic surgery (VATS) core needle biopsy of pulmonary nodules.
Methods: Data from 18 patients diagnosed with pulmonary nodules who underwent VATS core need biopsy were retrospectively reviewed.
Results: Of the 18 patients, 15 had malignancies (primary lung cancer, n=14; metastatic lung cancer, n=1), and 3 had benign nodules. Mortality and pleural metastasis did not occur during the follow-up period.
Conclusion: In patients with solitary pulmonary nodules that require tissue confirmation, computed tomography-guided percutaneous cutting needle biopsy or diagnostic pulmonary resection sometimes may not be feasible choices due to the location of the solitary pulmonary nodule or the patient's impaired pulmonary function, VATS core needle biopsy may be performed in these patients as an alternative method.

Keywords: Video-assisted thoracic surgery, Solitary pulmonary nodule, Large-core needle biopsy

Introduction

Chest computed tomography (CT) is a screening test for people at high risk of developing lung cancer, and increasingly many cases of pulmonary nodules have been detected incidentally [1]. Many of these variably sized and shaped nodules are benign tumors. However, when the possibility of malignancy cannot be excluded, tissue confirmation is often required [2,3]. The most widely used biopsy methods for pulmonary nodules are CT-guided percutaneous cutting needle biopsy (PCNB) and endobronchial ultrasound-guided transbronchial needle aspiration biopsy (EBUS-TNA) [4-6]. However, CT-guided PCNB and EBUS-TNA cannot be used in all patients with pulmonary nodules. If a pulmonary nodule is close to the hilum, great vessels, heart, or aorta, there is an elevated risk of pulmonary complications, such as hemo-pneumothorax or massive bleeding due to vessel injury during needle biopsy. If a pulmonary nodule is too small (<1 cm) to be easily localized, CT-guided PCNB and EBUS-TNA may not be performed. In such cases, wedge resection of the portion of the lung containing the pulmonary nodule is possible [7]. If a pulmonary nodule is relatively large (>4 cm) or close to the hilum, proper resection of the pulmonary nodule can be achieved only by expanding the range of lung resection and performing segmentectomy or lobectomy (Fig. 1). Diagnostic lobectomy or segmentectomy is commonly performed and usually does not lead to major complications [8,9]. The proportion of pulmonary nodules determined to be cancer in biopsy results varies greatly depending on their size and shape [10,11]. If a biopsy is performed with extended lung resection, such as diagnostic lobectomy or segmentectomy, and the nodule is benign, the patient may have been subjected to unnecessary risk [12,13]. Despite slight differences depending on the pulmonary lobes, lung function deteriorates by 10%–20%

https://doi.org/10.5090/jcs.22.063

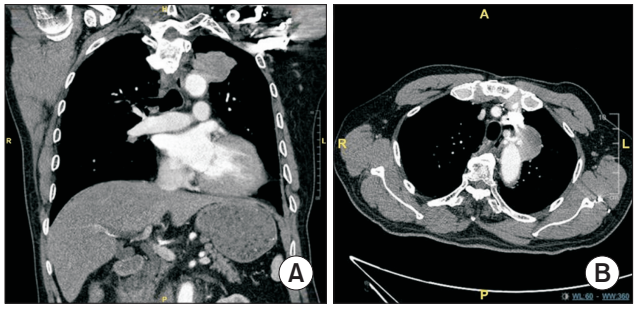

Fig. 1. (A, B) Large solitary pulmonary nodule (4.5 cm) in a patient with impaired pulmonary function (predicted postoperative forced expiratory volume in 1 second: 42.5%). A, anterior; P, posterior; L, left; R, right.

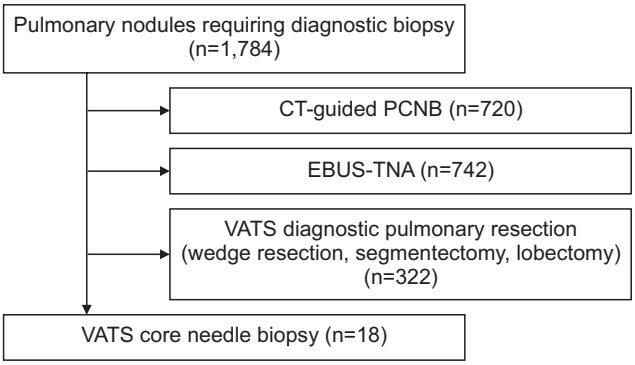

Fig. 2. Flow chart for patient selection in this study. VATS, video-assisted thoracoscopic surgery; CT, computed tomography; PCNB, percutaneous cutting needle biopsy; EBUS-TNA, endobronchial ultrasound-guided transbronchial needle aspiration.

on average after lobectomy [14,15]. In patients with lung diseases such as chronic obstructive pulmonary disease (COPD) or interstitial lung disease (ILD), or with a history of pulmonary infection or asthma, the recovery of lung function after lobectomy is likely to be difficult, and mortality and morbidity may occur more frequently [16-19]. Therefore, if diagnostic lobectomy is judged to have a risk of inducing postoperative complications due to the patient's impaired lung function, VATS core needle biopsy can be considered as an alternative to pulmonary resection [20]. This method, in which the surgeon confirms the exact location of the pulmonary nodule and conducts a biopsy, enables highly accurate diagnoses and minimizes stapler use, thereby alleviating the patient's economic burden. However, several studies have shown that malignant pleural recurrence is more likely after CT-guided PCNB than after tissue biopsy via lung resection [21-23]. As the malignant pulmonary nodule is not completely excised during VATS core needle biopsy, pleural spreading of cancer cells is possible during the procedure. Thus, this study aimed to evaluate the feasibility and safety of VATS core needle biopsy for pulmonary nodules.

Methods

From 2018 to 2022, 1,784 patients with pulmonary nodules incidentally detected on radiology required biopsy. Pulmonary nodules located in the peripheral region required tissue biopsy through CT-guided PCNB. Central or endobronchial lesions were biopsied through EBUS-TNA. If biopsy through CT-guided PCNB or a bronchoscopic approach was not appropriate, wedge resection of the pulmonary nodule was an alternative; the decision of whether to perform extended pulmonary resection was made according to the frozen section pathology report. Among the included patients with pulmonary nodules, those who had impaired lung function according to the predicted postoperative forced expiratory volume in 1 second (ppoFEV1) (40%< ppoFEV1 <60% or ppoFEV1 <1.00 L) with underlying pulmonary diseases such as COPD, asthma, or ILD underwent VATS core needle biopsy (Fig. 2), followed by additional surgery depending on the frozen section pathology report. A total of 18 patients underwent tissue confirmation with VATS core needle biopsy, and their data were obtained through a retrospective chart review. Of the 18 patients, 14 were men and 4 were women, and their average age was 69.9 years. For all patients, contrast-enhanced chest CT was performed as a preoperative examination, and the surgical direction was determined according to the location and size of the confirmed pulmonary nodule. To evaluate the patient's lung function, a pulmonary function test and a diffusing capacity of the lung for carbon monoxide test were performed (Table 1).

This retrospective study was approved by the Institutional Review Board of Gyeongsang National University Medical Center (approval no., 2022-05-004) and adhered to the Declaration of Helsinki (as revised in 2013). Informed consent was obtained from all included patients.

The patients were administered general anesthesia through double-lumen endotracheal tubing and maintained a lateral position during the operation. After advancing to the pleural cavity with a thoracoscope, the location of the central mass was determined. Most of the pulmonary masses were centrally located and were often close to the pulmonary vessels and bronchus. After making a working port (4 cm) in the fifth intercostal space on the middle axillary line, the pulmonary nodule was located with a fingertip or a thoracoscopic device, and VATS core

Table 1. Characteristics of patients

Characteristic	Value
Age (yr)	69.9 (50–82)
Sex	
Male	14
Female	4
Underlying pulmonary disease	
Chronic obstructive pulmonary disease	14
Asthma	1
Interstitial lung disease	3
ppoFEV1 (%)	54.3 (31.6–77.9)
ppoDLCO (%)	82.95 (39.3–121)
Drainage period (day)	7.3 (2–20)
Postoperative period (day)	10.5 (3–25)
Follow-up period (day)	759 (12–1,476)

Values are presented as mean (range) or number of patients.
ppoFEV1, predicted postoperative forced expiratory volume in 1 second; ppoDLCO, predicted postoperative diffusing capacity of the lung for carbon monoxide.

needle biopsy was then performed. Lateral traction of the lung with a lung clamp can be very helpful for preventing large vessel injury. After this maneuver, core needle biopsy with an appropriate device (Max-Core Disposable Core Biopsy Instrument 18G×20 cm; BD Corp., Franklin Lakes, NJ, USA) could be performed safely (Fig. 3). Around 2–5 needle punctures in a core needle biopsy could obtain sufficient specimens for the diagnosis of pulmonary nodules. Pulmonary parenchymal bleeding from small branches of the pulmonary vessels after core needle biopsy was successfully controlled with gauze compression. In cases of primary lung cancer diagnosed based on the frozen section pathology report, lobectomy with mediastinal lymph node dissection was performed when complete resection was possible according to the preoperative evaluation. If the lesion was confirmed to be benign, surgery was terminated after bleeding control and irrigation using distilled water without additional lung resection. Continuous variables were presented as the mean, median, range, and standard deviation. Categorical variables were presented as the frequency with the associated percentages. All statistical analyses were performed using IBM SPSS ver. 22.0 (IBM Corp., Armonk, NY, USA).

Results

In this study, all 18 patients who underwent VATS core needle biopsy had a pathologic diagnosis confirmed after surgery. Fifteen patients were diagnosed with malignancies and 3 with benign lesions. Of the 15 patients with malignancies, 14 were diagnosed as having primary lung cancer:

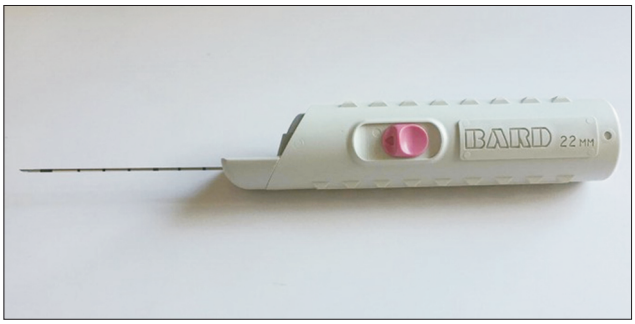

Fig. 3. Max-Core Disposable Core Biopsy Instrument (18G×20 cm; BD Corp., Franklin Lakes, NJ, USA).

Table 2. Malignant lesions diagnosed by video-assisted thoracoscopic core needle biopsy

Diagnosis	No. of patients	Size (cm) (mean, range)
Primary lung cancer		
Adenocarcinoma	11	3.5 (1.9–7)
Squamous cell carcinoma	3	3.6 (2.1–6.2)
Metastatic lung cancer		
Leiomyosarcoma	1	5.5
Benign tumor		
Organizing pneumonia	1	4.5
Chronic bronchiolitis	1	1.2
Capillary hemangioma	1	2.2

11 had adenocarcinoma and 3 had squamous cell carcinoma. One patient was diagnosed with pulmonary metastasis from leiomyosarcoma. The 3 patients with benign lesions were diagnosed with organizing pneumonia, chronic bronchiolitis with pulmonary fibrosis, and capillary hemangioma, respectively (Table 2). Among the patients diagnosed with primary lung cancer, 8 who were eligible for curative surgery underwent VATS lobectomy with mediastinal lymph node dissection. The remaining 6 patients did not undergo extended pulmonary resection due to possible distant metastasis on the positron emission tomography–CT scan performed as part of the preoperative evaluation. Extended pulmonary resection was not performed for the patient diagnosed with pulmonary metastasis (leiomyosarcoma) and 2 patients with benign tumors. A patient diagnosed with capillary hemangioma underwent VATS lobectomy with mediastinal lymph node dissection. The average sizes of the malignant and benign lesions were 3.5 cm (range, 1.2–7 cm) and 2.6 cm (range, 1.2–4.5 cm), respectively. All 18 patients underwent VATS without conversion to thoracotomy. No complications occurred during the biopsy, and the amount of bleeding was less than 10 mL. The average follow-up period for all patients was 759 days, but

2 patients were lost to follow-up: one was diagnosed with benign disease and the other refused additional treatment after being diagnosed with advanced-stage lung cancer. After VATS core needle biopsy, no ipsilateral pleural metastasis was reported.

Discussion

It is very important to perform tissue confirmation of pulmonary nodules suspected of malignancy on a radiological examination. Pulmonary nodules located in the peripheral area can be diagnosed relatively clearly with CT-guided PCNB or surgical resection such as wedge resection. For relatively large peripheral pulmonary nodules, percutaneous needle biopsy is easy. Conversely, if the nodule is relatively small or there is a ground glass nodule in a peripheral location, biopsy can be performed by wedge resection by VATS. Due to its low difficulty and ability to obtain sufficient pathologic results after extracting the mass, many centers perform biopsy through VATS wedge resection, which has been accepted as a very successful tissue confirmation technique. For central solitary pulmonary nodules located close to the bronchus, bronchoscopic biopsy is mainly performed for histological examinations, and various techniques are additionally used to improve the accuracy of bronchoscopic biopsy [24]. However, when a central nodule is located far from the segmental bronchus, it can be difficult to obtain a specimen for a pathologic diagnosis from a bronchoscopic biopsy, which leads to the choice to perform extended pulmonary resection (e.g., segmentectomy or lobectomy). Patients with suspected lung cancer are often old, and lung function often deteriorates in these patients due to underlying diseases such as COPD, asthma, and ILD. Performing extended pulmonary resection for diagnostic purposes in these patients may increase the likelihood of postoperative mortality and morbidity. In such cases, VATS core needle biopsy can be considered as an alternative. VATS core needle biopsy can prevent morbidity and mortality due to the deterioration of lung function that can occur after lung resection in patients with impaired lung function and can serve as a more straightforward method of tissue confirmation than lung resection. There are a few points to note when performing VATS core needle biopsy. A risk of pleural metastasis exists when the biopsy is performed with only a needle rather than performing complete excision for tissue biopsy. In addition, to perform VATS core needle biopsy, a sufficient understanding of the anatomy in the pleural cavity is necessary because structures such as the heart, aorta, and pulmonary vessels can be injured during a needle biopsy. Pleural metastasis could be prevented by massive irrigation using distilled water after VATS core needle biopsy, and there were no patients with pleural metastasis in this study. Injuries of the great vessels could be prevented with a sufficient field of view during surgery. Minor bleeding of less than 10 mL due to lung injury occurred in some cases, and could be controlled by gauze compression. There were no cases of major bleeding caused by VATS core needle biopsy. Therefore, VATS core needle biopsy is a feasible and safe method for tissue confirmation of pulmonary nodules. In this study, VATS core needle biopsy was confirmed to be an effective diagnostic tool for highly selected patients with pulmonary nodules. This technique might not be performed in all patients with pulmonary nodules because CT-guided PCNB, EBUS-TNA, and complete resection of the pulmonary nodule are also considered. However, if tissue confirmation through any of these methods is difficult, VATS core needle biopsy may be considered as an alternative. This study also has some limitations. Most importantly, this study analyzed a relatively small number of cases from a single institution. Therefore, large prospective studies are needed to determine the feasibility of VATS core needle biopsy for pulmonary nodules in highly selected patients.

Article information

ORCID

Yong-Seong Lee: https://orcid.org/0000-0003-0789-3916
Jong Duk Kim: https://orcid.org/0000-0003-0268-1674
Hyun-Oh Park: https://orcid.org/0000-0003-1302-6456
Chung-Eun Lee: https://orcid.org/0000-0003-4469-7201
In-Seok Jang: https://orcid.org/0000-0003-1929-6238
Jun-Young Choi: https://orcid.org/0000-0001-7774-8541

Author contributions

Conceptualization: YSL. Data curation: YSL. Formal analysis: JDK. Methodology: CEL. Project administration: JDK. Visualization: ISJ. Writing–original draft: JYC. Final approval of the manuscript: all authors.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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