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| RESEARCH ARTICLE

Diagnostic Value of Ultrasound-Guided Core Needle Biopsy in the Diagnosis of Pulmonary Masses at Ho Chi Minh City Oncology Hospital

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| ABSTRACT

Histopathological confirmation is essential for the diagnosis of pulmonary masses. Although computed tomography (CT)-guided transthoracic biopsy is widely used, it remains associated with a relatively high complication rate, especially pneumothorax. Ultrasound-guided core needle biopsy is a practical alternative for peripheral lung lesions abutting the pleura. This study aims to evaluate the diagnostic performance and safety of ultrasound-guided core needle biopsy for pulmonary masses at Ho Chi Minh City Oncology Hospital. A cross-sectional descriptive study was conducted in 136 consecutive patients with peripheral pulmonary masses visible on ultrasound who underwent ultrasound-guided core needle biopsy from July 2024 to February 2025. Demographic characteristics, lesion size, depth, pleural contact length (PCL), procedure time, number of tissue cores, pathological results, and complications were analyzed. The mean age was 62.3 ± 11.1 years, and 72.8% of patients were male. Definitive histopathological diagnosis was achieved in 128/136 cases (94.1%). Malignancy was identified in 107 cases (78.7%), including 90 primary lung malignancies and 17 metastatic lesions. Mean procedure time was 15.6 minutes, and a mean of 4.9 ± 1.17 cores was obtained per patient. Pneumothorax occurred in 10 patients (7.4%), all mild and self-limited, and mild hemoptysis occurred in 2 patients (1.5%). No severe complications or procedure-related deaths were observed. Ultrasound-guided core needle biopsy is a safe, efficient, and accurate technique for diagnosing peripheral pulmonary masses. It provides a high diagnostic yield with a low complication rate and is a valuable first-line biopsy approach for appropriately selected pleural-based lung lesions.

| KEYWORDS

ultrasound-guided biopsy; core needle biopsy; lung mass; peripheral pulmonary lesion; diagnostic yield; pneumothorax

| ARTICLE INFORMATION

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1. Introduction

Lung cancer is one of the most common malignancies and a leading cause of cancer-related mortality worldwide. Histopathological confirmation is required to establish the nature of pulmonary lesions and guide treatment. Image-guided transthoracic biopsy is therefore a key diagnostic approach. CT-guided lung biopsy has been widely adopted with high diagnostic accuracy, but it is associated with a substantial complication rate, particularly pneumothorax, which may occur in up to one quarter of patients, and some patients require chest drainage (Heerink et al., 2017).

In addition, CT-guided biopsy usually requires a longer procedure time and exposes patients to ionizing radiation. In this context, ultrasound-guided core needle biopsy has emerged as an effective alternative for peripheral lung lesions in contact with the pleura. Previous studies have shown that ultrasound-guided lung biopsy can achieve diagnostic performance comparable to CT-guided biopsy while reducing complication rates and shortening procedural time (Fu et al., 2019; Lee et al., 2018; Portela-Oliveira et al., 2021; Yang et al., 2015). Lee et al. (2018) reported that ultrasound-guided biopsy was associated with fewer

complications than CT guidance and shorter mean procedure time. Yang et al. (2015) also demonstrated a high diagnostic success rate with a low rate of mild pneumothorax.

Ultrasound-guided biopsy of peripheral pulmonary lesions is now widely applied in clinical practice, and published series have reported that such cases account for approximately 14.89% to 35.71% of thoracic biopsies in interventional radiology settings (Kayastha et al., 2024). At Ho Chi Minh City Oncology Hospital, ultrasound-guided biopsy of pulmonary masses has been performed since 2019. This study was conducted to evaluate the diagnostic value and safety of ultrasound-guided core needle biopsy for pulmonary masses at our institution.

2. Materials and Methods

2.1. Study design and setting

This cross-sectional descriptive study was performed at Ho Chi Minh City Oncology Hospital. The study included patients with pulmonary masses who underwent ultrasound-guided core needle biopsy from July 2024 to February 2025.

2.2. Study population

Eligible participants were patients with chest wall-adjacent pulmonary masses that could be visualized on ultrasound. Inclusion criteria were suspected malignant pulmonary lesions located peripherally and amenable to ultrasound guidance. Exclusion criteria included severe uncontrolled coagulopathy, lesions not visible on ultrasound, and moderate to large pleural effusion.

2.3. Biopsy procedure

All procedures were performed by an interventional radiologist with more than 8 years of biopsy experience. All patients were informed about the procedure and provided written consent before biopsy. Patients were positioned according to lesion location in the supine, prone, or lateral decubitus position.

Ultrasound was performed with an appropriate transducer, typically a convex probe with a frequency of 3.5-5 MHz. After skin antisepsis with 2% povidone-iodine, local anesthesia was administered using 2% lidocaine. A semi-automatic 18-gauge core biopsy needle was used in all cases. Under real-time ultrasound guidance, the trocar was advanced into the lesion and the core needle was then deployed through the trocar. Usually, 5-6 tissue cores were obtained, unless localized pneumothorax developed or adequate cores could no longer be sampled.

Biopsy specimens were placed in 10% formalin. Immediately after the procedure, tissue core quality and local complications were assessed. Patients were monitored clinically during the first 4 hours, and pleural ultrasound or chest radiography was performed if respiratory symptoms occurred. Follow-up during the first 24 hours after the procedure was used to detect early complications. Final pathology, immunohistochemistry, surgical pathology, or imaging follow-up for benign/nondiagnostic lesions was used as the reference standard.

2.4. Data collection and statistical analysis

Quantitative variables included age, lesion size, lesion depth, pleural contact length, procedure time, and number of tissue cores. Qualitative variables included sex, lesion location, pathological classification, diagnostic yield, and complications. Data were analyzed with SPSS version 20.0 using descriptive statistical methods. Continuous variables are presented as mean ± standard deviation or median with interquartile range, and categorical variables are presented as frequencies and percentages.

2.5. Ethical considerations

The study was conducted in accordance with institutional ethical standards and the principles of the Declaration of Helsinki. All patients were informed about the procedure and signed consent before biopsy.

3. Results

3.1. Baseline demographic and lesion characteristics

A total of 136 patients were included. The mean age was 62.3 ± 11.1 years (range, 24-84 years), with a median of 63 years (IQR, 57-70 years). There were 99 men (72.8%) and 37 women (27.2%), corresponding to a male-to-female ratio of approximately 3:1. All biopsied lesions were peripheral pulmonary masses. The mean lesion size on CT was 60.4 ± 24.0 mm, whereas the mean ultrasound-measured diameter was 56.7 ± 22.8 mm. The mean lesion depth from the skin surface was 44.9 ± 19.4 mm, and the mean pleural contact length was 49.7 ± 23.2 mm. Additional baseline lesion characteristics are summarized in Table 1.

Table 1. Baseline demographic and lesion characteristics of the study population

Variable	Value
Total patients	136
Age, mean ± SD (years)	62.3 ± 11.1
Age range (years)	24-84
Median age (IQR)	63 (57-70)
Male, n (%)	99 (72.8)
Female, n (%)	37 (27.2)
Lesion size on CT, mean ± SD (mm)	60.4 ± 24.0
Lesion size on ultrasound, mean ± SD (mm)	56.7 ± 22.8
Lesion depth, mean ± SD (mm)	44.9 ± 19.4
Pleural contact length, mean ± SD (mm)	49.7 ± 23.2
Right lung lesions, n (%)	65 (47.8)
Left lung lesions, n (%)	71 (52.2)
Upper lobe lesions, n (%)	83 (61.0)
Lower lobe lesions, n (%)	41 (30.0)
Right middle lobe lesions, n (%)	10 (7.4)
Lingular lesions, n (%)	2 (1.5)

3.2. Diagnostic and safety outcomes according to lesion size

Lesions 31-59 mm and lesions ≥60 mm comprised most of the cohort, while only 15 lesions measured ≤30 mm on CT. Diagnostic yield remained high across all lesion-size groups, ranging from 90.6% to 97.1%. Primary malignancy became more frequent as lesion size increased. Procedure-related pneumothorax was uncommon overall, although it was proportionally higher in the 31-59 mm group than in the other groups. Detailed outcomes stratified by lesion size are presented in Table 2.

Table 2. Diagnostic and procedural outcomes according to lesion size on CT

Variable	≤30 mm (n=15)	31-59 mm (n=53)	≥60 mm (n=68)
Primary malignancy, n (%)	5 (33.3)	29 (54.7)	56 (82.4)
Metastatic lesion, n (%)	3 (20.0)	8 (15.1)	6 (8.8)

Variable	≤30 mm (n=15)	31-59 mm (n=53)	≥60 mm (n=68)
Benign lesion, n (%)	6 (40.0)	11 (20.8)	4 (5.9)
Nondiagnostic, n (%)	1 (6.7)	5 (9.4)	2 (2.9)
Diagnostic yield, %	93.3	90.6	97.1
Pneumothorax, n (%)	1 (6.7)	8 (15.1)	1 (1.5)
Mild hemoptysis, n (%)	0 (0.0)	0 (0.0)	2 (2.9)
Lesion depth, mean ± SD (mm)	24.4 ± 10.4	35.4 ± 13.2	56.8 ± 17.0
Pleural contact length, mean ± SD (mm)	32.3 ± 15.1	36.5 ± 14.5	63.8 ± 21.6
Number of cores, mean ± SD	4.73 ± 1.10	4.89 ± 1.49	5.21 ± 0.78
Procedure time, mean ± SD (min)	17.1 ± 4.3	14.6 ± 4.8	16.1 ± 4.4

3.3. Outcomes according to pleural contact length

Pleural contact length was closely related to both diagnostic success and complication rate. Diagnostic yield increased from 84.6% in lesions with a pleural contact length <30 mm to 95.1% in lesions with a pleural contact length >60 mm. In contrast, pneumothorax was markedly more frequent in the group with a pleural contact length <30 mm. These findings are summarized in Table 3.

Table 3. Diagnostic yield and complications according to pleural contact length

Variable	PCL <30 mm (n=26)	PCL 30-60 mm (n=69)	PCL >60 mm (n=41)
Lesion size on CT, mean ± SD (mm)	37.6 ± 11.8	55.7 ± 16.2	83.0 ± 22.8
Diagnostic tissue obtained, n (%)	22 (84.6)	62 (89.9)	39 (95.1)
Malignant lesion, n (%)	12 (46.2)	57 (82.6)	38 (92.7)
Benign lesion, n (%)	11 (42.3)	8 (11.6)	2 (4.9)
Pneumothorax, n (%)	6 (23.1)	3 (4.3)	1 (2.4)
Mild hemoptysis, n (%)	0 (0.0)	1 (1.4)	1 (2.4)
Procedure time, mean ± SD (min)	14.38 ± 5.48	15.75 ± 4.49	16.20 ± 4.18
Number of cores, mean ± SD	4.00 ± 1.65	5.09 ± 0.95	5.17 ± 0.86

3.4. Overall pathological findings and complication profile

A definitive pathological diagnosis was established in 128 of 136 cases (94.1%), whereas 8 cases (5.9%) were nondiagnostic because the tissue obtained was insufficient or the result was considered false negative on follow-up. Among the 128 diagnostic cases, 107 lesions (78.7% of all cases) were malignant and 21 (15.4%) were benign. Of the malignant lesions, 90 were primary

pulmonary malignancies and 17 were metastatic lesions. The distribution of patient and lesion characteristics by pathological category is shown in Table 4.

Among primary lung malignancies, non-small cell lung carcinoma predominated, including 72 adenocarcinomas, 10 squamous cell carcinomas, 3 poorly differentiated carcinomas, and 5 small cell lung carcinomas. Benign lesions included 7 cases of pulmonary tuberculosis, 8 cases of chronic inflammatory lung tissue, 2 cases of chronic granulomatous inflammation, and 4 lesions confirmed as benign by imaging follow-up over at least 3 months. Procedure time averaged 15.6 minutes overall, and 4.9 ± 1.17 cores were obtained per patient. No severe complications or procedure-related deaths occurred. Pneumothorax developed in 10 patients (7.4%) and was mild in all cases, while mild hemoptysis occurred in 2 patients (1.5%). Pain was absent or mild in 120 patients (88.2%), moderate in 14 (10.3%), and severe in only 2 (1.5%).

Table 4. Characteristics according to pathological classification

Variable	Primary malignant (n=90)	Metastatic (n=17)	Benign (n=21)	Nondiagnostic (n=8)
Age, mean ± SD (years)	63.8 ± 9.9	58.9 ± 11.0	57.3 ± 14.7	65.5 ± 9.6
Sex (male/female)	68/22	11/6	13/8	7/1
Lesion size on ultrasound, mean ± SD (mm)	63.2 ± 21.8	47.5 ± 18.9	38.6 ± 15.9	50.5 ± 25.0
Lesion size on CT, mean ± SD (mm)	67.1 ± 24.1	50.8 ± 20.4	42.3 ± 15.6	53.4 ± 15.9
Lesion depth, mean ± SD (mm)	50.7 ± 17.9	34.2 ± 15.4	29.1 ± 13.8	43.6 ± 25.1
Pleural contact length, mean ± SD (mm)	55.6 ± 23.5	41.8 ± 19.0	35.1 ± 16.0	38.0 ± 20.3
Number of cores, mean ± SD	5.0 ± 1.0	4.9 ± 0.9	4.8 ± 1.3	3.6 ± 2.3
Procedure time, mean ± SD (min)	16.4 ± 4.4	15.2 ± 4.0	14.2 ± 4.7	12.0 ± 6.0
Diagnostic adequacy, %	92.2	100.0	100.0	25.0
Pneumothorax, %	3.3	5.9	14.3	37.5
Mild hemoptysis, %	2.2	0.0	0.0	0.0

4. Discussion

This study showed that ultrasound-guided core needle biopsy is an effective and safe method for diagnosing peripheral pulmonary masses. The overall diagnostic yield of 94.1% in our cohort is highly consistent with previous reports, which have generally documented diagnostic rates of approximately 90–95% for ultrasound-guided biopsy of pleural-based thoracic lesions (Phuong et al., 2022; Portela-Oliveira et al., 2021; Yang et al., 2015).

The high proportion of malignant lesions in our series (78.7%) likely reflects the referral pattern of a tertiary oncology hospital. This finding is comparable to previously published data from similar interventional settings, where malignant disease accounted for most biopsied pulmonary lesions (Kayastha et al., 2024; Yang et al., 2015). Most malignant lesions in the present study were primary lung cancers, predominantly adenocarcinoma, followed by squamous cell carcinoma and small cell lung carcinoma.

Although the mean lesion size in our study was relatively large, ultrasound guidance also performed well for smaller lesions. Lesions measuring ≤30 mm still achieved a diagnostic yield of 93.3%, which supports the clinical usefulness of this technique in selected small peripheral masses. Lee et al. (2018) reported that ultrasound guidance could provide high-quality tissue sampling even for small pleural-contact lesions and may outperform CT guidance in certain subgroups.

Pleural contact length appeared to be an important technical determinant in our study. Diagnostic yield increased as pleural contact length increased, whereas pneumothorax decreased markedly. Lesions with pleural contact length <30 mm had the lowest diagnostic yield and the highest complication rate. This finding is biologically plausible, because a limited pleural interface provides a narrower access window and increases technical difficulty during real-time needle manipulation (Lee et al., 2018; Portela-Oliveira et al., 2021).

The safety profile in our cohort was favorable. Pneumothorax occurred in only 7.4% of cases and was mild in all patients, while hemoptysis was rare and self-limited. No patient required invasive management for complications. These results compare favorably with the higher pneumothorax rates commonly reported for CT-guided transthoracic biopsy (Heerink et al., 2017). Other ultrasound-guided series have similarly shown low rates of pneumothorax and bleeding complications (Gershman et al., 2022; Yang et al., 2015).

Another practical advantage of ultrasound-guided biopsy is procedural efficiency. The mean procedure time in our series was 15.6 minutes. In addition to avoiding ionizing radiation, ultrasound-guided biopsy may shorten waiting time and improve access to tissue diagnosis when lesions are pleural-based and readily visible sonographically (Mychajlowycz et al., 2021).

This study has several limitations. First, it was a single-center descriptive study without a direct CT-guided comparison group. Second, only lesions visible on ultrasound were included, so the findings cannot be generalized to deeper intraparenchymal lesions. Third, post-procedural follow-up was short, which limited assessment of delayed complications. Finally, multivariable statistical modeling was not performed to identify independent predictors of diagnostic success or complications.

Despite these limitations, the present findings support the use of ultrasound-guided core needle biopsy as a valuable first-line diagnostic approach for appropriately selected peripheral pulmonary masses.

5. Conclusion

Ultrasound-guided core needle biopsy is a safe, rapid, and highly effective technique for the diagnosis of peripheral pulmonary masses. In this series of 136 patients, the procedure achieved a diagnostic yield of 94.1% with a low complication rate, limited mainly to mild pneumothorax and mild hemoptysis, and no severe adverse events. Pleural contact length appears to be an important determinant of both technical success and complication risk. These results support ultrasound-guided core needle biopsy as a valuable first-line option for appropriately selected pleural-based lung lesions.

Declarations

Ethics approval and consent to participate: The study was conducted in accordance with institutional ethical standards and the Declaration of Helsinki. All patients provided informed consent before undergoing biopsy.

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Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions: Huynh Thi Do Quyen conceptualized the study and drafted the manuscript. Pham The Hung supervised the study and critically revised the manuscript. Nguyen Vinh Thinh contributed to data analysis and interpretation. Huynh Khanh Phu contributed to investigation and pathology data verification. All authors read and approved the final manuscript.

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