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Diagnostic Accuracy and Safety Between two Needle Sizes in Percutaneous Trans-Thoracic Biopsy for the Evaluation of Pulmonary Lesions

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ABSTRACT

Background: Percutaneous trans-thoracic lung biopsy has a crucial role in diagnosing lung lesions including lung cancer. However, there is no clear guideline regarding the needle size in percutaneous trans-thoracic lung biopsy. This study aims to evaluate the diagnostic accuracy and complication rate between two needle sizes for percutaneous trans-thoracic lung biopsy.

Methods: A retrospective review of patients with lung lesions who underwent percutaneous trans-thoracic lung biopsy between November 2010 and December 2019 was performed. The demographic data, imaging finding, biopsy technique, complication and histologic outcome were recorded and analyzed. Propensity score matching was done to reduce bias in baseline characteristics.

Results: Of 377 patients who underwent percutaneous trans-thoracic lung biopsy, 331 patients had complete information. The patients were divided in two groups, comprising of 153 patients in 18G needle group and 178 patients in 20G needle group. After propensity score matching, there were 126 patients left in each group. The diagnostic accuracy, sensitivity, specificity, positive predictive value and negative predictive value for 18G needle group were 92.9%, 98.1%, 65.0%, 93.7% and 86.7%, respectively. For 20G needle group, the diagnostic accuracy, sensitivity, specificity, predictive value and negative predictive value were 96.0%, 99.0%, 83.3%, 96.2% and 95.2%, respectively. The immediate complication rate was 35.7% and 31.7% in 18G and 20 G needle groups (p= 0.505), respectively.

Conclusions: There was no difference in diagnostic accuracy and immediate complication rates between 18G and 20G needle use for percutaneous trans-thoracic lung biopsy.

Keywords: Complication rates; diagnostic accuracy; needle sizes; percutaneous lung biopsy; propensity score matching.

INTRODUCTION

Precise tissue diagnosis of lung pathology is crucial. It can be obtained from various methods like percutaneous trans-thoracic lung biopsy (PTLB), either by CT or ultrasound guidance, bronchoscopic lung biopsy, open lung biopsy and video-assisted thoracoscopic surgery (VATS) each with various complication rates.[1]

Nowadays, PTLB has been precise and widely used method for indications like newly detected mass, cases of pulmonary infiltration not diagnosed from sputum examination and hilar masses negative on bronchoscopy.[1] The diagnostic accuracy in PTLB depends on factors such as size of lesion, technique and equipment used with possible complications like pneumothorax and hemorrhage.

There are only few studies which reported the effect of needle size in biopsy results for the evaluation of pulmonary lesions.[2-4] However, there is still no clear recommendation. Hence, this study aims to evaluate the diagnostic accuracy and complication rate between two needle sizes, 18 guage (G) and 20 guage (G), for PTLB.

METHODS

This retrospective review study included patients with lung lesions who underwent percutaneous trans-thoracic

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lung biopsy at the Intervention Radiology Unit of super specialized tertiary teaching hospital, Siriraj Hospital, Bangkok, Thailand, between November 2010 and December 2019. It was approved by the institutional ethics committee (COA no. Si 729/2020). The procedures were done after taking informed consent from each patient. The radiographic findings and procedure information of each patient were reviewed by a radiology resident and an interventional radiology staff using picture archiving and communication system (PACS). Patients were excluded if they had incomplete data.

Imaging finding included the type, site and size of the pulmonary lesions, the distance from the lesion to the adjacent pleura and/or presence of pleural effusion along the needle path were recorded. The lesion types were classified into solid nodule, mass, part-solid nodule, pure ground-glass opacity, cavitary lesion, consolidation and pleural thickening.[1]

Biopsy technique included percutaneous trans-thoracic lung biopsy which was first done by ultrasound guidance, if possible, due to it being safe, quick and inexpensive. CT guide was an alternate. When the position of needle was confirmed, tissue biopsy was done by 18G or 20G semi-automated biopsy needle in the cutting needle biopsy (CNB) kit. The needle was inserted via upper border of a rib to avoid intercostal vessel. Every needle adjustment was made when the patient held his or her breath. Coaxial technique was used to gain multiple cuts of tissue and decrease the number of needle insertions. We retrospectively recorded the biopsy site, imaging guide, number of needle gauge, and number of biopsy pass.

Immediate complication rate and type of complication were recorded. The discharge summary was then reviewed and classified the complication into A-F according to Society of Interventional radiology (SIR) adverse event classification.[5] Subgroup analysis by excluding the pleural based lesions (length from pleura to closest lesion surface along needle path = 0) was also performed.

Histologic outcome was recorded and classified as "positive" (malignancy or suspicious for malignancy), "negative" (no malignancy found including benign neoplasm, specific infection or non-specific finding such as fibrosis or inflammation), or "non-evaluable" (found only normal tissue).

The final diagnosis was concluded from medical record review combining a histologic result from surgery, microbiological examination or clinical and radiological follow up at least 12 months. It was then classified into "positive" (histologic result from surgery was a malignancy or suspicious for malignancy, and/or the clinical and radiological follow-up suggested malignant aetiology) or "negative" (histologic result from surgery showed no malignancy, and/or the clinical and radiological follow up suggested benign aetiology).

After that, the histologic result from percutaneous trans-thoracic lung biopsy was compared with the final diagnosis and classified into five categories; "True-positive" (positive histologic result from the biopsy with positive final diagnosis), "True-negative" (negative histologic result from the biopsy with negative final diagnosis), "False-positive" (positive histologic result from the biopsy with negative final diagnosis), "False-negative" (negative histologic result from the biopsy with positive final diagnosis), Non-evaluable (non-evaluable histologic result regardless of final diagnosis).

Lee et al. proposed that non-evaluable results make the unsolved diagnosis and additional medical procedures are required.[6] Therefore, non-evaluable results should be considered as a diagnostic failure whether the final diagnosis was benign or malignant and counted as false-negative categories when calculating sensitivity and false-positive categories when calculating specificity.

Statistical Analysis included continuous variables which were expressed as means ± SD or medians (interquartile range), and categoric variables were expressed as numbers (percentage).

Baseline characteristics, imaging characteristics, biopsy technique and histologic outcome were compared between patients with 18G and 20G needle size using the independent T-test or Mann Whitney U test for continuous variables and Fisher's Exact test or Chi-squared test for categoric variables, as appropriate.

To assess the independent diagnostic test (accuracy, sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV)) of needle size, we performed propensity score matching using length from pleura to closest lesion surface along needle path and maximal diameter of a lesion as indicators. Then, baseline characteristics, imaging characteristics, biopsy technique and histologic outcome after matching were compared between two groups using the same test as before matching.

The non-evaluable results were considered as false-negative categories when calculating sensitivity and false-positive categories when calculating specificity.[7]

RESULTS

From November 2010 to December 2019, 377 patients underwent percutaneous trans-thoracic lung biopsy at Interventional Radiology Unit. 46 patients with incomplete information were excluded. A total of 331

patients were evaluated (Figure 1).

The univariate analysis results comparing characteristics between 18G and 20G needle groups were shown in Table 1 and Table 2. Gender (p-value = 0.08), length from pleura to closest lesion surface (p-value < 0.001), maximal diameter of lesion (p-value < 0.001) and imaging guide technique (p-value < 0.001) were statistically different between the two groups (Table 1). In the 20G group, the length from pleura to closest lesion surface was longer (6 vs. 0 mm), the lesion size was smaller (27 vs. 41 mm) and more CT-guided technique (74.7% vs. 56.9%) was used.

The propensity score matching was done using length from pleura to closest lesion surface and maximal diameter of a lesion as indicators to reduce bias between 18G and 20G needle groups resulting in 126 patients in each group.

After propensity score matching, gender (p = 0.256), length from pleura to closet lesion surface (p = 0.583) and maximal diameter of lesion (p = 0.262) were no longer statistically different between the two groups but the imaging guide (p = 0.023) still showed a difference. (Table 1)

Table 1. Comparison of baseline characteristics between patients with 18G and 20G needle (Before and after propensity score matching).

Characteristics	Before propensity score matching			After propensity score matching		
	Value			Value		
	18G (n=153)	20G (n=178)	P-value	18G (n=126)	20G (n=126)	P-value
Age (years)	63 ± 13	63 ± 14	0.882	62 ± 13	63 ± 14	0.808
Sex			0.008			0.256
Male	87(56.9%)	75(42.1%)		64(50.8%)	55(43.7%)	
Female	66(43.1%)	103(57.9%)		62(49.2%)	71(56.3%)	
Imaging Characteristics						
Site of biopsy			0.705			0.638
Right upper lobe	40 (26.1%)	42 (23.6%)		31(24.6%)	31(24.6%)	
Right middle lobe	11 (7.2%)	9 (5.1%)		10 (7.9%)	8 (6.3%)	
Right lower lobe	36 (23.5%)	53 (29.8%)		29(23.0%)	37(29.4%)	
Left upper lobe	33 (21.6%)	37 (20.8%)		25(19.8%)	26(20.6%)	
Left lower lobe	33 (21.6%)	36 (20.2%)		31(24.6%)	23(18.3%)	
Length from pleura to closest lesion surface along needle path (mm)	0 (0-12)	6 (0-23)	≤0.001	0 (0-14)	1 (0-14)	0.583
Maximal diameter of lesion (mm)	41(27-63)	27(20-43)	≤0.001	35(24-54)	32(22-48)	0.262
Pleural effusion along needle path			0.089			0.060
- Present	1 (0.7%)	6 (3.4%)		0 (0.0%)	5(4.0%)	
- Absent	152(99.3%)	172(96.6%)		126(100.0%)	121(96.0%)	
Biopsy technique						
Imaging guide			≤0.001			0.023
- CT	87 (56.9%)	133(74.7%)		77 (61.1%)	84 (66.7%)	
- Ultrasound	26 (17.0%)	26 (14.6%)		17 (13.5%)	26 (20.6%)	
- Combined CT and Ultrasound	40 (26.1%)	19 (10.7%)		32 (25.4%)	16 (12.7%)	
Number of needle passes	4 (1-12)	4 (1-17)	0.896	4 (3-5)	4 (3-5)	0.397

*Values are number (%), mean ± SD or median (IQR) unless otherwise as indicated.

Table 2. Comparison of complication and between patients with 18G and 20G needle (Before and after propensity score matching).						
Characteristics	Before propensity score matching			After propensity score matching		
	Value		P-value	Value		P- value
	18G (n=153)	20G (n=178)		18G (n=126)	20G (n=126)	
Complications						
Immediate complication rate	53 (34.6%)	64 (36.0%)	0.803	45 (35.7%)	40 (31.7%)	0.505
Complication classification			0.828			0.833
- A	6 (11.3%)	9 (14.1%)		5 (11.1%)	5 (12.5%)	
- B	44 (83.0%)	50 (78.1%)		38 (84.4%)	32 (80.0%)	
- C	0 (0.0%)	0 (0.0%)		0 (0.0%)	0 (0.0%)	
- D	3 (5.7%)	5 (7.8%)		2 (4.4%)	3 (7.5%)	
- E	0 (0.0%)	0 (0.0%)		0 (0.0%)	0 (0.0%)	
- F	0 (0.0%)	0 (0.0%)		0 (0.0%)	0 (0.0%)	
Histologic outcomes						
Histologic category						
- True positive	129(84.3%)	139(78.1%)		104 (82.5%)	101(80.1%)	
- True negative	14 (9.2%)	30 (16.9%)		13 (10.4%)	20 (15.9%)	
- False positive	0 (0.0%)	0 (0.0%)		0 (0.0%)	0 (0.0%)	
- False negative	2 (1.3%)	2 (1.1%)		1 (0.8%)	0 (0.0%)	
- Non-evaluable	8 (5.2%)	7 (3.9%)		8 (6.3%)	5 (4.0%)	

**Values are number (%), mean ± SD or median (IQR) unless otherwise as indicated.*

The details of characteristic of lung lesion, histologic results and type of complication were shown in Table 2 and Table 3.

Table 3. Imaging characteristic, histologic type and complication type.		
Characteristics	Value	
	18G (n=153)	20G (n=178)
Imaging Characteristics		
Type of lesion		
Solid nodule	40 (26.1%)	92 (51.7%)
Mass	103 (67.3%)	68 (38.2%)
Part-solid nodule	4 (2.6%)	4 (2.2%)
Pure ground glass opacity	0 (0.0%)	1 (0.6%)
Cavitary lesion	1 (0.7%)	6 (3.4%)
Consolidation	5 (3.3%)	5 (2.8%)
Pleural thickening	0 (0.0%)	2 (1.1%)
Histologic outcomes		
Histologic type		
Malignancy		
Primary lung cancer		
Adenocarcinoma of lung	65 (42.5%)	76 (42.6%)
Squamous cell carcinoma of lung	10 (6.5%)	9 (5.1%)
Small cell carcinoma of lung	5 (3.2%)	4 (2.2%)
Undifferentiated cancer of lung	8 (5.2%)	7 (3.9%)
Lymphoma	5 (3.2%)	2 (1.1%)
Malignant thymoma	1 (0.7%)	2 (1.1%)
Metastatic lung cancer	35 (23%)	39 (22.1%)
Benign	16 (10.5%)	32 (18%)
Non-evaluable	8 (5.2%)	7 (3.9%)

**Values are number (%), mean ± SD or median (IQR) unless otherwise as indicated.*

The histological outcome showed 84.3% patients in 18G needle group and 78.1% patients in 20G needle group who had a positive result for malignancy. Adenocarcinoma of the lung was the most common histologic result (42.6%).

The non-evaluable results were found in 8 patients (5.2%) in 18G needle group and 7 patients (3.9%) in 20G needle group.

Before propensity score matching, the diagnostic accuracy, sensitivity, specificity, PPV and NPV for 18G needle group were 93.5%, 97.7%, 66.7%, 94.8% and 82.3%, respectively and for 20G needle group those were 94.9%, 97.9%, 83.3%, 95.9% and 90.9%, respectively.

The diagnostic success group in 18G needle group (n = 143) consisted of 129 true-positive results and 14 true-negative results; the diagnostic failure group (n = 10) consisted of 2 false-negative results and 8 non-evaluable results.

The diagnostic success group in 20G needle group (n = 169) consisted of 139 true-positive results and 30 true-negative results; the diagnostic failure group (n = 9) consisted of 2 false-negative results and 7 non-evaluable results.

Diagnostic accuracy, sensitivity, and specificity showed no statistical difference between 18G and 20G needle groups.

After propensity score matching, the diagnostic accuracy, sensitivity, specificity, PPV and NPV for 18G needle group were 92.9%, 98.1%, 65.0%, 93.7% and 86.7%, respectively and for 20G needle group those were 96.0%, 99.0%, 83.3%, 96.2% and 95.2%, respectively.

The diagnostic success group in 18G needle group (n = 117) consisted of 104 true-positive results and 13 true-negative results; the diagnostic failure group (n = 9) consisted of 1 false-negative results and 8 non-evaluable results.

The diagnostic success group in 20G needle group (n = 121) consisted of 101 true-positive results and 20 true-negative results; the diagnostic failure group (n = 5) consisted of 5 non-evaluable results without false-positive or false-negative result.

Diagnostic accuracy, sensitivity, and specificity still showed no statistical difference between 18G and 20G needle groups with p = 0.271, p = 1.000 and p = 0.162, respectively.

The immediate complication after percutaneous trans-thoracic lung biopsy occurred in 53 patients (34.4%) using 18G needle and 64 patients (36.0%) using 20G needle. In 18G needle group, A, B and D class-complication occurred in 6 (11.3%), 44 (83.0%) and 3 (5.7%) patients, respectively. In 20G needle group, A, B and D class-complication occurred in 9 (14.1%), 50 (78.1%) and 5 (7.8%) patients, respectively. The immediate complication rate was no statistical difference between 18G and 20G needle groups (p = 0.828).

Pneumothorax was the most common complication, occurring in 46 patients (29.9%) using 18G needle and 55 patents (30.9%) using 20G needle.

After propensity score matching, the immediate complication rate still showed no statistical difference between 18G and 20G needle groups (p = 0.505).

A total of 161 patients had non-pleural based lesions (55 patients in 18G needle group and 106 patients in 20G needle group) as shown in Table 4. Maximal diameter of lesion (p = 0.044) showed statistically difference between two needle groups. There was smaller lesion (22 vs. 29 mm) in 20G needle group. The propensity score matching was not done due to the limited sample size. The immediate complication rate was no statistically different between 18G and 20G needle groups (p = 0.900).

Table 4. Comparison of baseline characteristics, complication and histologic outcomes between patients with 18G and 20G needle (Non-pleural based lesions).

Characteristics	Value		P
	18G (n=55)	20G(n=106)	
Length from pleura to closet lesion surface along needle path (mm)	16 (9-27)	18 (10-31)	0.522
Maximal diameter of lesion (mm)	29 (20-36)	22 (16-34)	0.044
Complication			
Immediate complication rate	26 (47.3%)	49 (46.2%)	0.900
Complication classification			1.000
A	4 (15.4%)	8 (16.3%)	
B	20 (76.9%)	36 (73.5%)	
C	0 (0.0%)	0 (0.0%)	
D	2 (7.7%)	5 (10.2%)	
E	0 (0.0%)	0 (0.0%)	
F	0 (0.0%)	0 (0.0%)	

**Values are number (%), mean ± SD or median (IQR) unless otherwise as indicated.*

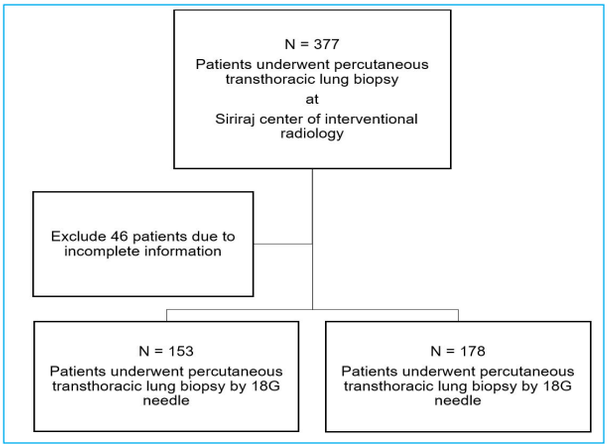

Figure 1. Patient enrollment of 377 patients who underwent percutaneous trans-thoracic lung biopsy at Siriraj center of interventional radiology from November 2010 to December 2019.

DISCUSSION

In this retrospective analysis of percutaneous trans-thoracic lung biopsies of 331 patients, we evaluated diagnostic accuracy and complication rates as primary and secondary outcomes, respectively. It was proven useful and safe tool for diagnosis of lung lesion as the results were within the range as per the literature reviewed.

After propensity score matching, the length from pleura to closest lesion surface ($p = 0.583$) and maximal diameter of lesion ($p = 0.262$) were no longer different between the two groups using 18 G and 20 G needles. This allowed us to compare histologic outcome and complication.

The diagnostic accuracy was slightly higher but still within the same range with the previous studies (92.9% and 96% vs. 77-98%).[2,3,6-11] In this study, the biopsies were done only by core needle biopsy technique which was different from previous studies that used either core needle biopsy or fine needle aspiration technique.[7]

This study's specificity was lower than previous studies, especially in 18G needle group (65% vs. 98-100%). This could be explained by non-evaluable classification. Non-evaluable histologic results in this study always classified to the diagnostic failure group which was not the same as previous studies that either excluding the non-evaluable results or regarding non-evaluable categories as negative results.[8,9,11-13]

The diagnostic accuracy and sensitivity were not statistically different in 18G and 20G needle groups in both before and after propensity score matching.

Specificity was also statistically indifferent (65.0% in 18G needle group vs. 83.3% in 20G needle group). This result could be due to the small sample size in true and false-negative groups (15 patients in 18G needle group vs. 21 patients in 20G needle group). Further study may be required to clarify this result.

After propensity score matching, the immediate complication rate and SIR complication classification showed no statistical difference between the two needle groups.

The immediate complication rate was 35.3%. The pneumothorax rate was 30.5% which was slightly higher but within the range of the previous studies (6.5-38%).[2,4,6,9,14] Choo et al. reported an overall complication rate of 12.1% and pneumothorax rate of 6.5% possibly due to different technique.[9] In our study, we used skin marker to locate the skin entry site then manually insert the needle. Whereas, their study used C-arm gantry and virtual navigation system to locate the skin entry site then real-time fluoroscopy was used during needle insertion. This enabled them to select targeting route more accurately which may lower the complication rate.

A meta-analysis from Yoon et al. found that deep-seated lesion was an independent risk factor for pneumothorax.[14] When we analysed only non-pleural based lesions, the immediate complication rate still showed no statistical difference. However, due to the limited sample size, propensity score matching was not done. So, the bias in baseline characteristic was not reduced. Further study is required to evaluate this subgroup analysis.

This study has several limitations. Firstly, it was a retrospective and single-center study which may result in selection bias. Secondly, long duration of study from 2010 to 2019 may result in different equipment and experience of the operator which may impact the histologic outcome and complication.

CONCLUSIONS

Percutaneous trans-thoracic lung biopsy plays a crucial role in the diagnosis of lung lesion. There is still no consensus guideline regarding needle size for percutaneous trans-thoracic lung biopsy. Our study shows no statistical difference in diagnostic accuracy and immediate complication rates between 18G and 20G needle groups. Nevertheless, further study may be required to clarify the result.

CONFLICT OF INTEREST

The authors declare no conflict of interest

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