

Diagnostic efficacy of computed tomography-guided transthoracic needle aspiration and biopsy in patients with pulmonary disease

Tibel Tuna¹
Sevket Ozkaya²
Adem Dirican²
Serhat Findik³
Atilla G Atici³
Levent Erkan³

¹Department of Pulmonary Medicine, Samsun Chest Diseases and Thoracic Surgery Hospital, ²Department of Pulmonary Medicine, Medical Park Samsun Hospital, ³Department of Pulmonary Medicine, Faculty of Medicine, Samsun Ondokuzmayis University, Samsun, Turkey

Background: Computed tomography-guided transthoracic needle aspiration (TTNA) and biopsy (TTNB) is a well established, safe, and rapid method of reaching a definitive diagnosis for most thoracic lesions. The present study aimed to determine the roles of TTNA and TTNB in the diagnosis of pulmonary diseases and to compare the results using these two techniques.

Methods: TTNB and TTNA were performed in 105 patients admitted to our clinic due to peripheral pulmonary lesions between May 2005 and November 2007. Needle biopsies were performed using 18-gauge Tru-Cut[®] biopsy needles and aspirations was performed using 18-20-22-gauge Chiba needles.

Results: Malignant lesions diagnosed by TTNB were non-small cell lung carcinoma (51 patients, 73%), small cell lung carcinoma (nine patients, 13%), malignant tissue (three patients, 5%), lymphoma (two patients, 3%), thymoma (two patients, 3%), plasmacytoma (one patient, 1%), rhabdomyosarcoma (one patient, 1%), and metastasis (one patient, 1%). The malignant lesions diagnosed by TTNA were non-small cell lung carcinoma in eleven patients (92%) and malignant tissue in one patient (8%). Three (100%) of the benign lesions diagnosed by TTNB were granulomas and two (100%) benign lesions diagnosed by TTNA were infarctions. When the diagnostic value of TTNB and TTNA was compared, TTNB was significantly superior. Malignant lesions were identified in 70 (84%) and benign lesions were identified in three (4%) of the 83 patients in the TTNB group. Ten (12%) patients in the TTNB group could not be diagnosed. Malignant lesions were found in 12 (55%) and benign lesions were found in two (9%) of the 22 patients in the TTNA group. Negative results were obtained in eight (36%) patients. The diagnostic sensitivity, specificity, and accuracy of TTNB was calculated to be 92%, 100%, and 93%, respectively (Table 5). The diagnostic sensitivity, specificity, and accuracy of TTNA was 78%, 100%, and 82%, respectively. TTNB had a sensitivity of 92% (70/76) in malignant cases and 100% (3/3) in benign cases, while the sensitivity of TTNA in malignant and benign cases was 75% (3/4) and 67% (2/3), respectively.

Conclusion: TTNB is a safe and easy procedure which provides a highly accurate diagnosis of benign and malignant lung lesions without causing a significant increase in complication rates.

Keywords: computed tomography, guided, transthoracic needle aspiration, transthoracic needle aspiration biopsy, pulmonary lesion

Introduction

Computed tomography-guided transthoracic needle aspiration (TTNA) and biopsy (TTNB) are well established, safe, and rapid methods for achieving a definitive diagnosis for most thoracic lesions, whether the lesion is located in the pleura, lung parenchyma, or mediastinum. This study aimed to determine the roles of TTNA and

Correspondence: Sevket Ozkaya
Medical Park Samsun Hospital,
Department of Pulmonary Medicine,
Samsun, Turkey
Tel +90 53 2474 1309
Email ozkayasevket@yahoo.com

TTNB in the diagnosis of pulmonary diseases and to compare the results using these two modalities.

Materials and methods

TTNB and TTNA were performed in 105 patients admitted to our clinic due to peripheral pulmonary lesions between May 2005 and November 2007. The two groups of patients were followed up prospectively. Laboratory blood tests, including platelet count, prothrombin time, and international normalized ratio, were done before the procedure. Lesion localization was defined by computed tomography. No premedication was administered to the patients before the procedure. Needle biopsies were performed using 18-gauge Tru-Cut® (Cook Endoscopy, Winston-Salem, NC, USA) biopsy needles and aspirations were performed using 18-20-22-gauge Chiba needles (Cook Medical Inc., Bloomington, IN, USA). Biopsy and aspiration materials were fixed in alcohol and sent for pathologic examination. All patients were evaluated by computed tomography immediately after the procedure, and those patients at risk for pneumothorax were further evaluated by chest X-ray several hours later. TTNB or TTNA was performed on each patient. Demographic characteristics, history, physical examination findings, laboratory values, radiologic findings, diagnoses, and complication rates were recorded for both groups. Statistical analyses of the data were performed using Statistical Package for the Social Sciences version 13 software (SPSS Inc., Chicago, IL, USA). The results are presented as the mean \pm standard deviation or as percentages. Chi-square analysis and specificity and sensitivity tests were performed for analysis of the data.

Results

One hundred and five patients, consisting of 19 females and 86 males, were included in the study (Table 1). Their

Table 1 Clinical and demographic characteristics of the patients

	TTNB	TTNA	Total
Age	60 \pm 12	59 \pm 8	
Gender (M/F)	67/16	19/3	86/19
Symptoms			
Chest pain	27	7	34
Dyspnea	20	2	22
Cough	18	6	24
Hemoptysis	5	2	7
Fatigue	9	5	14
Neck mass	2	0	2
No symptoms	2	0	2
Total	83 (79%)	22 (21%)	105

Abbreviations: TTNB, transthoracic needle biopsy; TTNA, transthoracic needle aspiration.

Table 2 Radiologic characteristics

CT characteristic	TTNB	TTNA	Total	P
Mass, n (%)	67 (86)	11 (14)	78 (100)	0.006*
Consolidation, n (%)	7 (58)	5 (42)	12 (100)	0.774
Cavity, n (%)	4 (40)	6 (60)	10 (100)	0.754
Nodule, n (%)	5 (100)	0 (0)	5 (100)	0.063
Total, n (%)	83 (79)	22 (21)	105 (100)	0.001*

Note: * $P < 0.05$.

Abbreviations: CT, computed tomography; TTNB, transthoracic needle biopsy; TTNA, transthoracic needle aspiration.

mean age was 59.79 (range 20–80) years. The radiologic characteristics in each group were observed as masses, consolidation, cavities, and nodules on computed tomography (Table 2). The most frequent radiologic lesion was a mass (78 patients, 74%). Significantly more TTNBs were performed in patients presenting with a mass. No significant difference existed between the two procedures performed in patients with other lesions. Mass lesions were diagnosed as malignant and benign in 97% and 3% of patients, respectively (Table 3).

Lesion localizations on computed tomography were as follows: 35 (33.3%) in the right upper lobe; 14 (13.3%) in the right middle lobe; 16 (15.2%) in the right lower lobe; 16 (15.2%) in the left upper lobe; eight (7.6%) in the lingula; and 16 (15.2%) in the left lower lobe.

A definitive diagnosis was established in 87 of the 105 patients evaluated using a transthoracic procedure. The lesion was malignant in 82 (78%) patients and benign in five (5%) patients. Eighteen (17%) of the patients could not be diagnosed (Table 4 and Figure 1); of these 18 patients, a diagnosis was later established in ten patients by bronchoscopy (n=9) or clinically (n=1). A definitive diagnosis could not be established in the remaining eight patients (four in the TTNB group and four in the TTNA group).

The malignant lesions diagnosed by TTNB were non-small cell lung carcinoma in 51 (73%) patients, small cell lung carcinoma in nine (13%) patients, malignant tissue in three (5%) patients, lymphoma in two (3%) patients, thymoma in two (3%) patients, plasmacytoma in one (1%)

Table 3 Distribution of malignant and benign lesions according to CT characteristics

CT characteristic	Malignant	Benign	Total
Mass, n (%)	66 (97)	2 (3)	68 (100)
Consolidation, n (%)	7 (88)	1 (12)	8 (100)
Cavity, n (%)	6 (86)	1 (14)	7 (100)
Nodule, n (%)	3 (75)	1 (25)	4 (100)
Total, n (%)	82 (94)	5 (6)	87 (100)

Abbreviation: CT, computed tomography.

Table 4 Rates of diagnosis with TTNB and TTNA

Diagnosis	TTNB	TTNA	Total	P
Positive, n (%)	73 (84)	14 (16)	87 (100)	0.021
Negative, n (%)	10 (56)	8 (44)	18 (100)	
Total, n (%)	83 (79)	22 (21)	105 (100)	

Abbreviations: TTNB, transthoracic needle biopsy; TTNA, transthoracic needle aspiration.

patient, rhabdomyosarcoma in one patient (1%), and metastasis in one (1%) patient (Figure 2 and Figure 3).

The malignant lesions diagnosed by TTNA were non-small cell lung carcinoma in 11 (92%) patients and malignant tissue in one (8%) patient. Three (100%) of the benign lesions diagnosed by TTNB were granulomas, and two (100%) benign lesions diagnosed by TTNA were infarctions (Figure 2). When the diagnostic values of TTNB and TTNA were compared, TTNB was significantly superior ($P=0.021$, Table 4).

Malignant lesions were identified in 70 (84%) and benign lesions were identified in three (4%) of the 83 patients in the TTNB group. Ten (12%) patients in the TTNB group could not be diagnosed (Figure 1). Malignant lesions were found in 12 (55%) and benign lesions were found in two (9%) of the 22 patients in the TTNA group. Negative results were obtained in eight (36%) patients (Figure 1).

The diagnostic sensitivity, specificity, and accuracy for TTNB was calculated to be 92%, 100%, and 93%, respectively (Table 5). The diagnostic sensitivity, specificity, and accuracy for TTNA was 78%, 100%, and 82%, respectively (Table 6). TTNB had a sensitivity of 92% (70/76) in malignant cases and 100% (3/3) in benign cases, while the sensitivity of TTNA in malignant and benign cases was 75% (3/4) and 67% (2/3), respectively.

The most frequent complication during the transthoracic procedures was pneumothorax (eleven patients, 10%). There was no statistically significant difference in complication rates

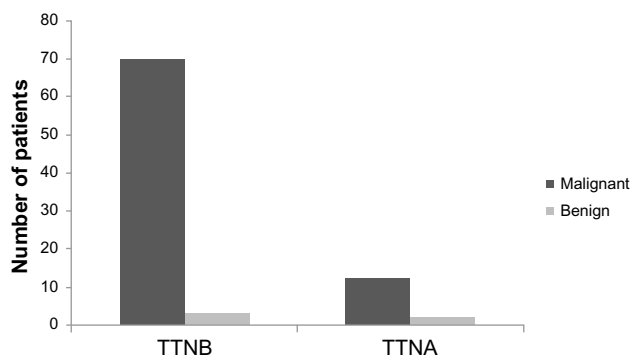


Figure 1 Distribution of malignant and benign lesions diagnosed by TTNB and TTNA. **Abbreviations:** TTNB, transthoracic needle biopsy; TTNA, transthoracic needle aspiration.

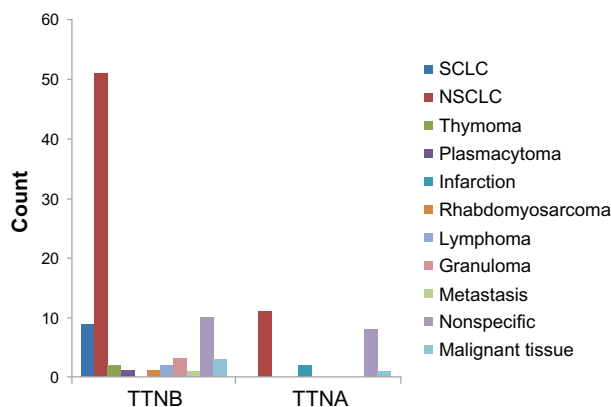


Figure 2 Pulmonary lesions diagnosed by TTNB and TTNA. **Abbreviations:** TTNB, transthoracic needle biopsy; TTNA, transthoracic needle aspiration; NSCLC, non-small cell lung cancer; SCLC, small cell lung cancer.

between the two procedures (Table 7). Chest tubes were placed in four of seven patients who developed pneumothorax during TTNB; three patients were monitored conservatively. A pneumothorax occurred in four patients during TTNA. Chest tubes were placed in two of the four patients, whereas the other two patients improved after monitoring and oxygen therapy.

Discussion

TTNA is a successful method that is performed in the diagnosis of malignant disease and the presence of a pathologist during the procedure increases the diagnostic value.¹ However, it is difficult to provide this arrangement in many centers. The sensitivity has been reported to be lower in benign lesions, ranging between 11% and 88%.^{2,3} In agreement with previous studies, the sensitivity of TTNA in malignant and benign lesions in the present study was 75% and 67%, respectively. When sampling pulmonary lesions, there is considerable interinstitutional variability in the technical performance of percutaneous needle biopsy of the lung, some performing computed tomography-guided fine needle aspiration biopsy for cytologic evaluation, others choosing percutaneous core biopsy of the lung, and others using a combination of both.⁴ Typically, percutaneous core biopsy of the lung involves insertion of a hollow large-bore needle, with a specially adapted cutting mechanism, into an organ to extract a

Table 5 Diagnostic values in patients in whom transthoracic needle biopsy (TTNB) was performed

	Number	Percentage (%)
Sensitivity	73/79	92
Specificity	4/4	100
Positive predictive value	73/73	100
Negative predictive value	4/10	40
Accuracy	77/80	93

Table 6 Diagnostic values in patients in whom transthoracic needle aspiration (TTNA) was performed

	Number	Percentage (%)
Sensitivity	14/18	78
Specificity	4/4	100
Positive predictive value	14/14	100
Negative predictive value	4/8	50
Accuracy	18/22	82

piece of tissue for histologic evaluation.⁵ While technically demanding, extensive experience documents percutaneous core biopsy of the lung as a safe and accurate procedure with limited morbidity and rare mortality.⁴⁻⁷ When compared with fine needle aspiration biopsy, percutaneous core biopsy of the lung seems to achieve a superior diagnostic accuracy for benign lung lesions (71%–97%) and a similarly high diagnostic accuracy for malignant lung tumors (88%–95%) with a comparable complication risk and without the need for onsite cytopathology.⁸⁻¹²

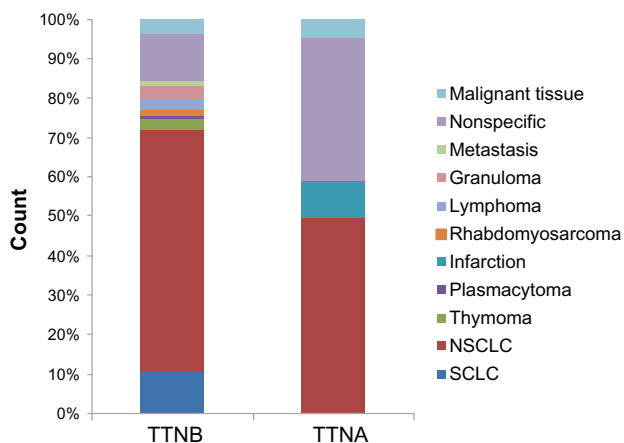
Kallenberg et al reported that transthoracic needle biopsy is a safe diagnostic procedure in patients with hematologic malignancies and has the potential of making specific diagnoses with minimal morbidity. In 53 patients with hematologic malignancies who underwent transthoracic needle biopsy during 1999–2007, the most common underlying hematologic malignancy was non-Hodgkin's lymphoma (n=20). Lesions were most frequently located in the left upper lobe (n=16); 33 lesions were pleural-based and nine had cavitation. Transthoracic needle biopsy established specific diagnoses in 22 patients (malignancies in 12 and infections in ten). Sensitivity for malignancy was 50.0%, sensitivity for infection was 40.0%, and there were no false-positive results.¹³

A study of 15,865 adults who had transthoracic needle biopsy of a pulmonary nodule found a 15% risk of pneumothorax, with 6.6% of all biopsies requiring a chest tube. Patients aged 60–69 years, smokers, and those with chronic obstructive pulmonary disease had higher risk for complications.¹⁴

Table 7 Complications during TTNB and TTNA

Complications	TTNB	TTNA	Total	P
Pneumothorax	7	4	11	0.114
Hemorrhage	1	0	1	
Hemoptysis	0	1	1	
None	75	17	92	
Total	83	22	105	

Abbreviations: TTNB, transthoracic needle biopsy; TTNA, transthoracic needle aspiration.

**Figure 3** Pulmonary lesions diagnosed by TTNB and TTNA.

Abbreviations: TTNB, transthoracic needle biopsy; TTNA, transthoracic needle aspiration; NSCLC, non-small cell lung cancer; SCLC, small cell lung cancer.

While obtaining more tissue is an advantage using TTNB, higher complication rates are a disadvantage. The sensitivities of TTNB were 92% (70/76) and 100% (3/3) in malignant and benign cases, respectively. Thus, TTNB was shown to be superior to aspiration in both conditions. On the other hand, there was no statistically significant difference in complication rates between the two procedures.

In conclusion, TTNB is a safe and easy procedure which provides a highly accurate diagnosis of benign and malignant lung lesions without causing a significant increase in complication rates.

Disclosure

The authors report no conflicts of interest in this work.

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