Research Article / Araştırma Makalesi

Transthoracic Lung Biopsy: A Retrospective Evaluation of the First Experiences in A Single Center

Transtorasik Akciğer Biyopsisi: Tek Bir Merkezdeki İlk Deneyimlerin Retrospektif Değerlendirmesi

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Abstract

Background: To evaluate the complication and success rates of transthoracic lung biopsies (TTLB) performed under computed tomography (CT) guidance, our first experience and compare them with the literature.
Materials and Methods: Thirty-four CT-guided transthoracic biopsies in 33 consecutive patients with lung lesions, using a 15-cm-long 16-gauge semi-automatic (coaxial) biopsy needle, were retrospectively evaluated. Age, gender, size of the lesion, location, distance to the pleura, needle insertion angle, patient position, presence of emphysema and/or complications (pneumothorax (PTX) and pulmonary hemorrhage (PH)), radiological findings before, during, and after the biopsy, and pathological diagnosis were retrieved from the patient files. The diagnostic success and failure of the method and the complication rates were noted.
Results: PTX and PH were observed in 9 and 7 patients, respectively, and 4 patients had both. The application of a chest tube was necessary in only 4 patients (4 of 9 patients with PTX). None of the patients with PH required additional procedures. The biopsy sample was adequate for a histopathologic evaluation in 32 patients with a diagnostic accuracy rate of 96.6%. The most frequent diagnosis was squamous cell carcinoma (11/33), followed by other types of primary lung tumors in 14 patients, breast carcinoma metastasis in 2 patients, and B-cell lymphoma in 1 patient.
Conclusions: The rate of complication due to CT-guided TTLB seemed to be comparable with the literature. PTX and PH may occur in up to one-fifth/-fourth of patients, but the management of these complications does not require additional procedures in the majority of patients, and the diagnostic accuracy rate is high.

Key Words: Lung, Computed Tomography, Transthoracic Biopsy, Diagnosis, Histopathology

Öz.

Amaç: Bilgisayarlı tomografi (BT) eşliğinde yaptığımız transtorasik akciğer biyopsilerinin komplikasyon ve başarı oranlarını, ilk deneyimlerimizi değerlendirmek ve literatür ile karşılaştırmak.
Materyal ve Metod: Akciğer lezyonu olan 33 ardışık hastada 15 cm uzunluğunda 16 gauge yarı otomatik (koaksiyel) biyopsi iğnesi kullanılarak BT eşliğinde 34 transtorasik biyopsi işlemi retrospektif olarak değerlendirildi. Yaş, cinsiyet, lezyonun boyutu, yerleşim yeri, plevraya uzaklık, iğne giriş açısı, hasta pozisyonu, amfizem ve / veya komplikasyon varlığı (pnömotoraks ve pulmoner hemoraji), biyopsi öncesi, sırası ve sonrasında radyolojik bulgular değerlendirildi ve patolojik tanılar hasta dosyalarından elde edildi. Yöntemin tanısal başarısı, başarısızlığı ve komplikasyon oranları not edildi.
Bulgular: Pnömotoraks ve pulmoner kanama sırasıyla 9 ve 7 hastada gözlendi ve 4 hastada her ikisi de vardı. Sadece 4 hastada göğüs tüpü uygulaması gerekti (9 hastanın 4'ü pnömotorakslı). Akciğer kanaması olan hastaların hiçbirine ek işlem gerektirmedi. Biyopsi örneği, tanısal doğruluk oranı % 96.6 olup, 32 hastada histopatolojik değerlendirme için yeterliydi. En sık tanı skuamöz hücreli karsinomdu (11/33), bunu 14 hastada diğer primer akciğer tümörleri, 2 hastada meme karsinom metastazı ve 1 hastada B hücreli lenfoma izledi.
Sonuç: BT eşliğinde transtorasik akciğer biyopsisine bağlı komplikasyon oranımız literatür ile benzer oranlardaydı. Pnömotoraks hastaların beşte birinde ve pulmoner kanama hastaların dörtte birinde ortaya çıkabilir, ancak bu komplikasyonların tedavisi hastaların çoğunda ek prosedürler gerektirmez ve tanısal doğruluk oranı yüksektir.

Anahtar kelimeler: Akciğer, Bilgisayarlı Tomografi, Transtorasik Biyopsi, Tanı, Histopatoloji

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Introduction

Computed tomography (CT)-guided transthoracic lung biopsy (TTLB) is a minimally invasive method that plays an important role in the diagnosis and, if necessary, the molecular characterization of lung lesions (1).

While the complication rate of fine needle lung biopsy is low, it may not provide a sufficient number of cells for the diagnosis and/or molecular profiling of the malignant lesions. Therefore, although the complication rates are higher, thick needle biopsy is preferred due to its higher diagnostic accuracy, enabling molecular testing for targeted therapy and immunotherapy, which significantly affects the treatment and prognosis of patients with lung cancer (2, 3). The coaxial technique is more widely used when compared to the non-coaxial technique. Since it is performed with fewer pleural punctures, the risk of developing pneumothorax (PTX) is expected to be lower when the coaxial technique is used. In addition, taking more than one sample from the lesion with the coaxial technique is easier for the practitioner. The aim of this study was to examine the results of CT-guided TTLB, which has recently begun to be performed in our clinic, in patients with lung lesions, and evaluate the success rates and incidence of complications.

Materials and Methods

The study was approved by the Adıyaman University Non-Interventional Ethics Committee (Approval no: 2020 / 9-32).

Case Selection

Thirty-three consecutive patients with a lung mass detected on thoracic CT examinations and/or chest radiographs, who applied to the interventional radiology unit for diagnosis, between February 2019 and October 2020, were included. Informed consent was obtained from the patients prior to the CT-guided TTLB.

CT-Guided TTLB Technique

Blood coagulation tests were performed before the procedure to make sure the patients did not have any coagulopathies. A CT device (Toshiba Aquilion model with 64 detectors, Toshiba Medical Tokyo Japan) was used to localize the lesion and guide the needle. Previous CT examinations of the patients were evaluated, and the patients were positioned in the most suitable position to provide the shortest distance between the lesion and the skin. After positioning, a metallic marker was placed on the skin, and CT images with a slice thickness of 3 mm were obtained before the procedure. Then, the appropriate angle to target the lesion was determined. The skin was cleaned with an antiseptic, local anesthesia with 2% prilocaine (Citanest; Dentsply, York, PA) was applied to all layers from the intercostal space to the skin. A 16-gauge (G) semi-automatic (coaxial) biopsy needle (Geotek Medical care Products) with a length of 15 cm was used for incisional biopsy. The procedure was performed through the upper surfaces of the costae, in order not to damage the intercostal vascular and neural structures. All of the procedures were performed under the guidance of CT, as it allows for the simultaneous visualization of complications during the procedure. All of the CT-guided TTLB procedures were performed by a single radiologist experienced in interventional radiology (M.Ç.).

Evaluation of the Findings

A total of 34 CT-guided TTLB performed on 33 patients were retrospectively reviewed. Findings on CT images taken before, during, and after the biopsy, as well as chest X-rays taken 4 h post-procedure, to evaluate the presence/absence of PTX and/or pulmonary hemorrhage (PH) were noted. The patients' age, gender, procedure time, size of the lesion, location, distance to the pleura, needle insertion angle, position, presence of emphysema, PTX, PH, and/or other complications, complication management history, and histopathological diagnosis were retrieved from the patient files. Moreover, the diagnostic success and failure rates of the method along with the complication rates were evaluated.

Statistical analysis

Data were analyzed using SPSS Statistics for Windows 23.0 (Armonk, NY: IBM Corp.). Descriptive statistics were expressed as the frequency (n) and percentage (%) for the categorical variables and as the mean ± standard deviation (SD) and minimum-maximum values for the continuous variables.

Results

Of the 33 patients included in the study, 24 were male and 9 were female. The mean age was 65.1±13.4 (range 18–85) years. The average lesion diameter was 52.6±23.3 (range 16–100) mm, and the mean distance to the pleura was 8.2±10.6 mm. The lesions were mostly located in the upper left lobe (n= 13; 39%), and the majority were solid lesions (n= 24; 72%) (Table 1). The average procedure time was 19.4±4.2 (range 13–30) min. No fissure was passed in any of the procedures and the needle penetration angle into the lung was measured as 80°–90° in the majority (n= 23), less frequently as 60°–79° (n= 7) and <60° (n= 4). The sampling was repeated up to 4 times (Table 2).

Complications occurred in 12 procedures (35%). Sampling was discontinued in 2 patients due to complications. After a chest tube was placed in 1patient, the procedure was repeated and then successfully completed without further complications (Figure 1). While PTX occurred in 9 and PH in 7 patients with complications, 4 patients had both PTX and PH (Figure 2).

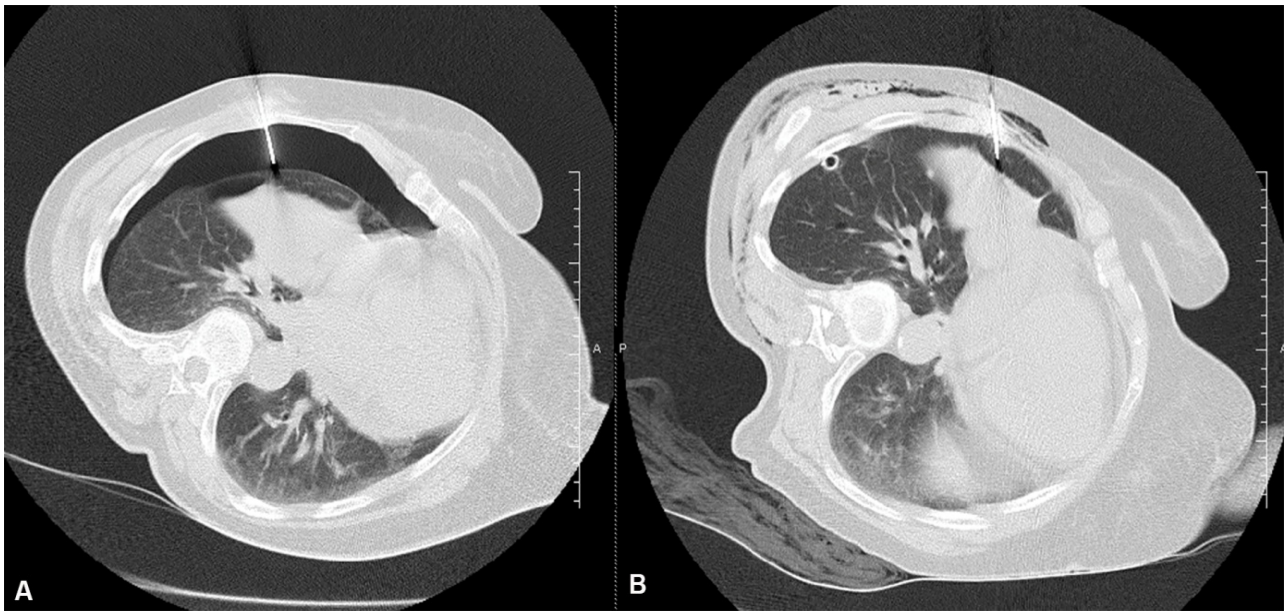

Figure 1. The procedure was terminated due to the occurrence of pneumothorax during TTLB on the mass in the right middle lobe of an 81-year-old woman. After the thorax tube was inserted, the procedure was continued with the thorax tube the next day. The patient was diagnosed with squamous cell carcinoma. No complications occurred during and after the second procedure.

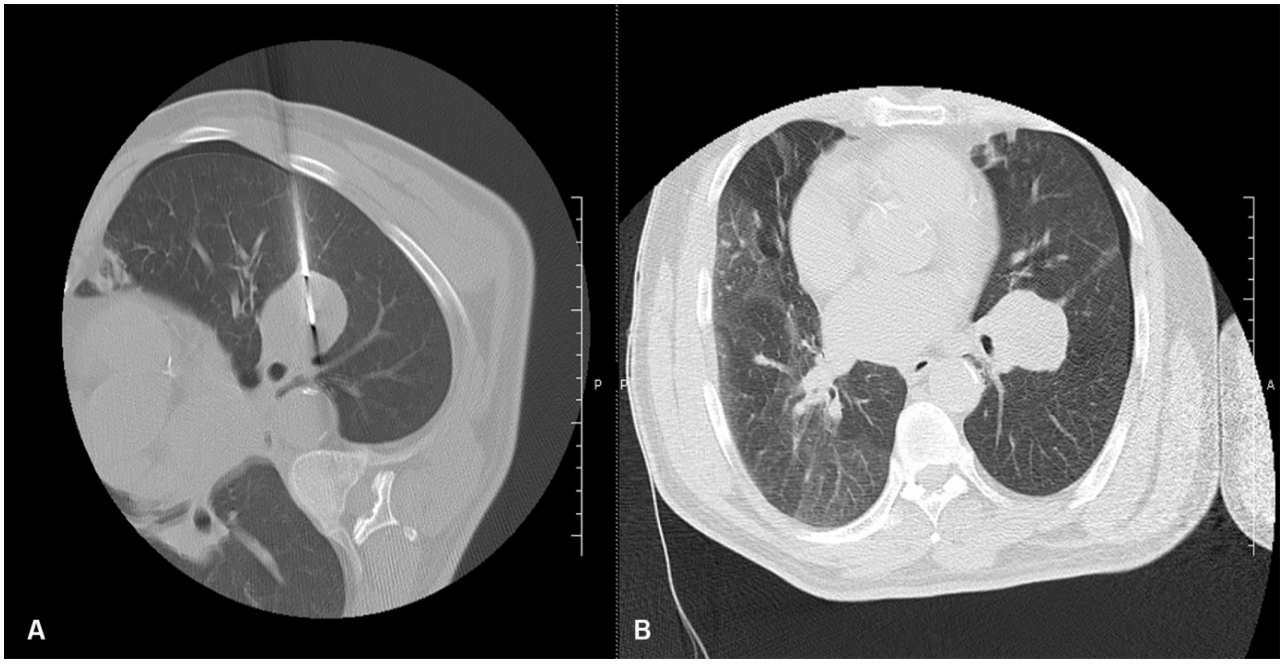

Figure 2. The well-circumscribed solid mass in the left hilar region of a 65-year-old male patient. Percutaneous TTLB was performed in the lateral decubitus position. Malignancy was ruled out in the patient as the histopathologic examination revealed a pulmonary hamartoma. Post-procedure CT showed mild pneumothorax and bleeding in the needle tract. The patient, who had no complaints and no worsening pneumothorax during follow-up, was discharged.

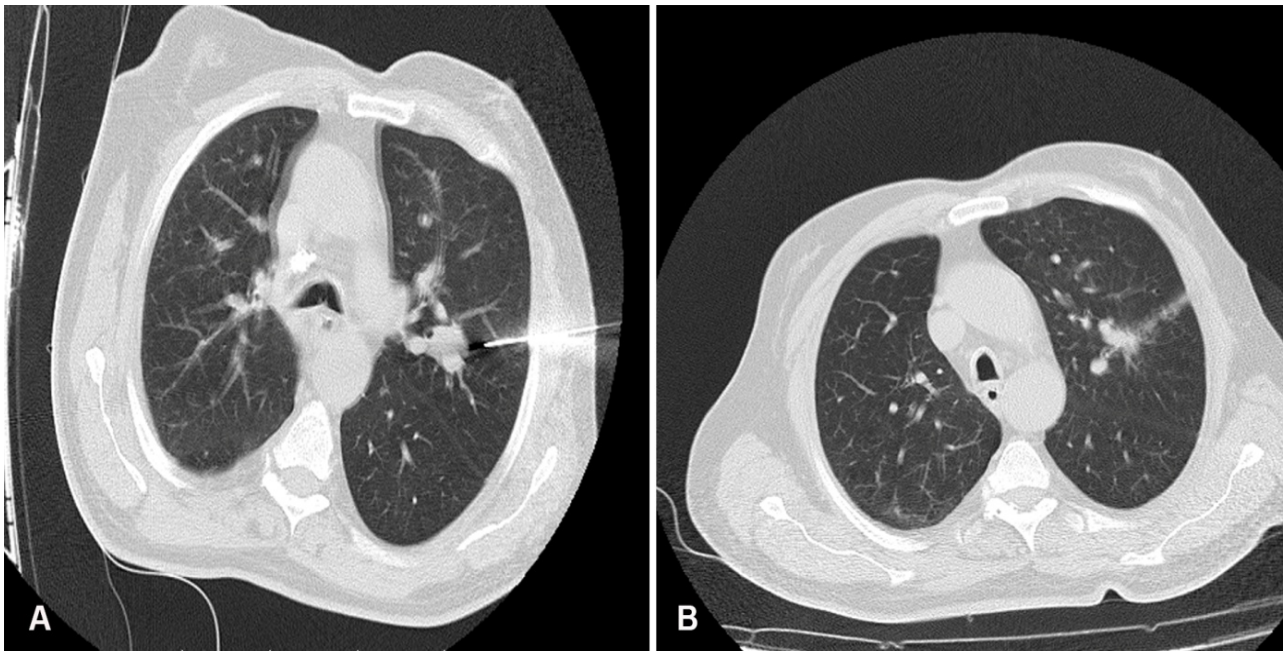

Figure 3. A 77-year-old male patient underwent TTLB due to a left upper lobe mass. Pathological diagnosis was made as squamous cell cancer. In the post-procedural CT, bleeding was observed in the needle tract. The patient, who had no complaints during follow-up, was discharged.

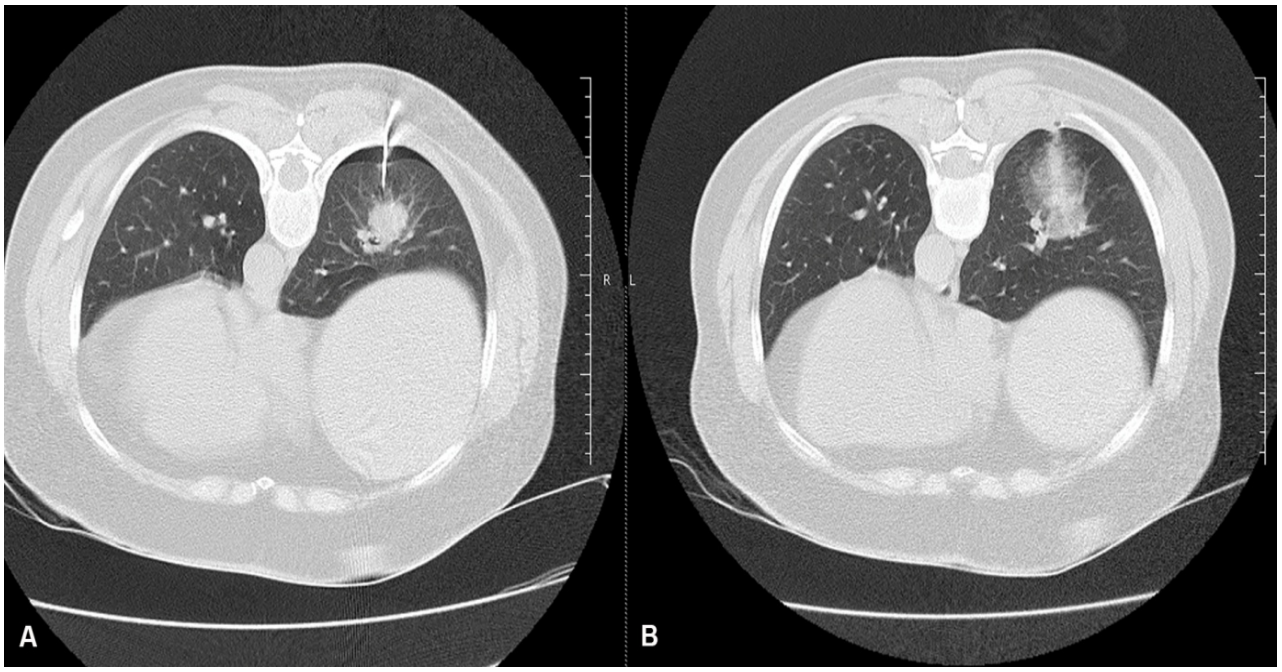

Figure 4. During the TTLB procedure performed on the mass in the right lower lobe of a 55-year-old female patient, minimal pneumothorax was observed while the needle was advanced towards the lesion. The procedure had to be discontinued due to hemoptysis in the patient. In the follow-up CT, hemorrhage was observed around the lesion and in the needle tract.

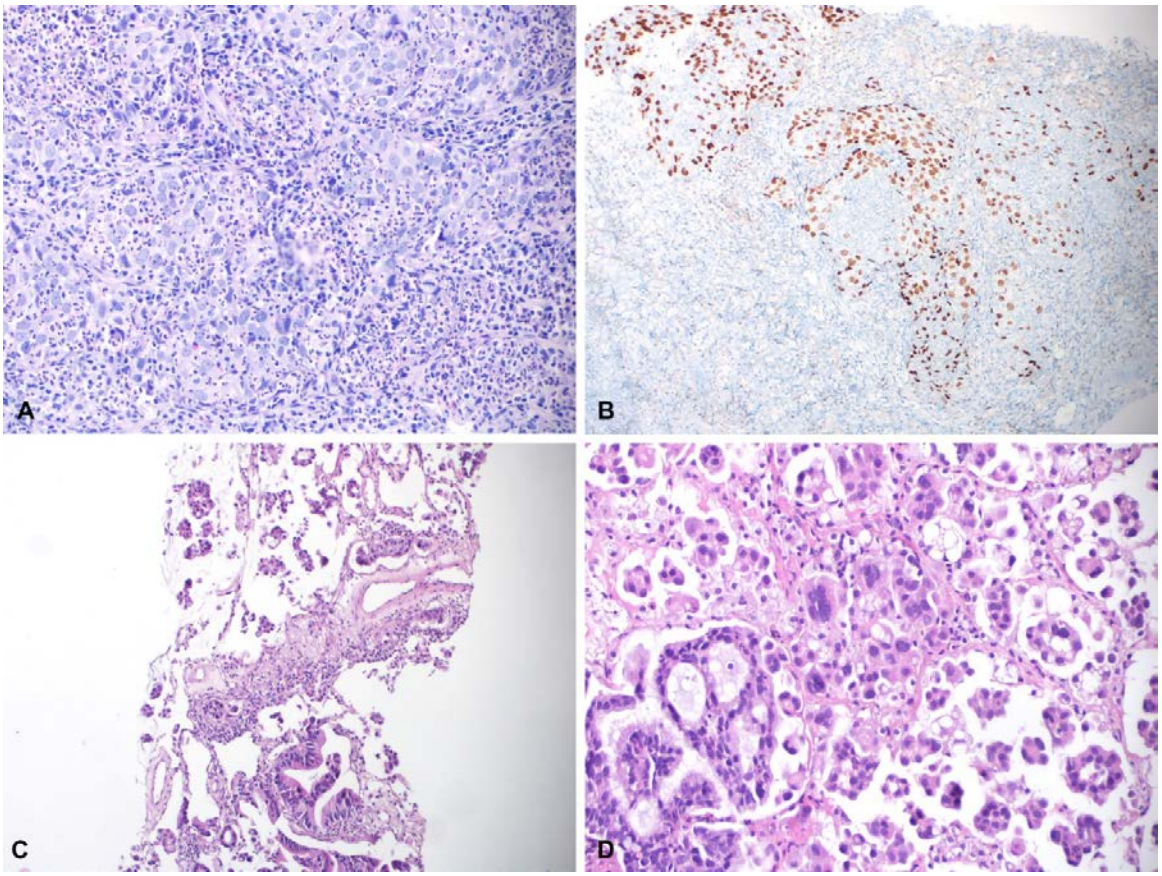

Figure 5. A-B) Squamous cell carcinoma, which was the most common diagnosis in thestudy group. A) Neoplastic infiltration composed of cells with oval nuclei, prominent nucleoli, and eosinophilic cytoplasm. Note the significant neutrophilic infiltration of the tumor. Hematoxylin eosin, x200, and B) P63 positivity in the tumor cells, supporting the squamous origin, immunohistochemistry, x100. C-D) Adenocarcinoma composed of acinar and micropapillary components, and hematoxylin-eosin, at x100 and x400.

Table 1. Patient and lesion characteristics

Patient Related Factors	
Mean Age ± SD	65.1 (±13.4); 18–85
Gender (n)	
Female	10
Male	23
Emphysema (n)	
Present	14
Absent	19
Lesion Related Factors	
Size (mm)	
Mean ± SD	52.6 (±23.3)
Range	18–100
Location (n)	
Right upper lobe	9
Right middle lobe	5
Right lower lobe	4
Left upper lobe	13
Left lower lobe	2
Distance to pleura (mm)	
Mean ± SD	8.2 (±10.6)
Range	0–32
Characteristic (n)	
Solid	24
Necrotic	3
Consolidated	5
Calcific	1

A chest tube was placed in 4 patients with PTX, and the average number of days of chest tube application was 4 (range 3–5) days. PH occurred within the needle tract in 5 patients, while it was perilesional in 4patients, and was located both in the biopsy tract and in the perilesional area in 2 patients (Figure 2–4). No additional bronchoscopic and/or endovascular intervention was required for the treatment of PH (Table 2).

The CT-guided TTLB sample was adequate for histopathological diagnosis, except 1 patient. In that particular patient, the biopsy procedure had to be discontinued due to hemo-PTX and significant perilesional bleeding. The majority of the patients (n=25) had primary malignant tumors, non-small cell types being the predominant type of tumor (n=23) (Table 3) (Figure 5). Moreover, 2 patients had breast cancer metastasis and the lesion was diagnosed as pulmonary hamartoma in 1 patient.

Table 2. Procedure details including complications

Position (n)	
Supine	8
Prone	9
Lateral decubitus	17
Number of samples (n)	
Mean ± SD	2.4 (±0.8)
Range	0–4
Thickness of the needle (G)	16 G
Processing time (min)	19.4±4.2; (Range 13–30 min)
Passing fissures (n)	
Yes	0
No	34
Presence of complications (n)	
Yes	12
No	22
Type of complication (n)	
Pneumothorax	9
Pulmonary hemorrhage (no additional treatment needed)	7
Need for chest tube insertion	4

Table 3. Results of the histopathologic evaluation.

	Diagnosis of the patients
Squamous cell carcinoma	11
Adenocarcinoma	9
Consistent with non-small cell carcinoma	3
Small cell/neuroendocrine carcinoma	2
Pulmonary hamartoma	1
Breast ca metastasis	2
B-cell lymphoma	1
Inflammation/organized pneumonia	2
Nonspecific changes	1
Inadequate/unsuccessful	1
Total	33

Discussion

As lung cancer is one of the leading causes of cancer-related deaths, the distinction of malignant lung lesions from benign entities is critical. TTLB is an important invasive procedure for diagnosis, especially in peripherally located lung lesions, and fiberoptic bronchoscopy (FOB) and/or endobronchial ultrasonography (EBUS) is used as the first choice in centrally located lesions. One of the most important factors in the development of complications is the location of the lesion. The diagnostic value of bronchoscopic biopsy may be limited, especially in peripheral lesions. In such cases, performing CT-guided TTLB plays an important role in both the diagnosis and, if necessary, in staging. It is a widely accepted diagnostic method for the diagnosis of lung lesions, with high diagnostic accuracy rates ranging from 71% to 95% (1–3). In addition, the biopsy sample is needed for molecular tests to determine the optimal targeted therapy for the patients with lung cancer (4).

The success and complication rates for CT-guided TTLB seemed to be similar to those reported in the literature. PTX is the most common complication and its frequency varies between 17% and 42% (5, 6), and PH, another common complication, may occur in up to 27% of patients (1, 5, 6). In the present study, PTX occurred in 26% of the study group and the frequency of PH was 20%, which was compatible with the literature. The rate of necessity for chest tube application during complication management (11%) also fell within the limits that were previously reported (2% to 18%) (7–10). Herein, 16-G needles were used for the procedure. In a recent meta-analysis by Heerink et al., which investigated the effect of a needle thickness between 16 and 20 G on complication rates, it was shown that different PTX and PH ratios were observed, even in the studies using the same needle thickness. However, overall, the authors found that the factors increasing the risk of complications were increased needle thickness, smaller lesion size, and increased parenchymal distance to be passed (11). In a study of 904 patients who underwent TTLB using 18- and 22-G needles, Sabatino et al. detected PTX in 33.8% of the patients, the need for chest tube in 5.9%, and PH in 32.7%. In that study, the size of the lesion, the distance of the lesion to the pleura, the presence of emphysema, the duration of the procedure, and the needle thickness were found to be significant factors affecting the complication rates (5). Although they used thinner needles than those used herein (18–20 G vs. 16 G), their complication rates were higher. Moreover, in their biopsy series, performed by using an 18-G needle, Laurent et al. and Khan et al. found PTX rates of 15.3% and 17%, chest tube necessity rates of 2% and 2.2%, and PH rates of 28.6% and 27.4%, respectively (12, 13). Although larger diameter needles were used herein, the PH rates were lower. However, the rate of PTX and chest tubes necessity was higher. These findings indicated that the complication rates and types may differ among different populations. It was preferred to assess the patients after the procedure with x-ray roentgenogram instead of CT because it contains less radiation. It could be preferred to carry out follow-up imaging with CT if it was needed in the present cases, just as Dusak et al. preferred CT imaging for drainage in cases with empyema for the management of complications that could not be corrected with tube thoracostomy (14).

Using a 16-G needle, Branden et al. and Billich et al. determined the PTX rates as 36% and 34%, the PH rates as 10.8% and 2.9%, and the need for chest tubes as 5.8% and 11.4%, respectively (15,16). When compared to the current study, while the rate of PTX was lower herein, the PH rate was higher. The reason for this may have been the difference in the definition of PH (bleeding in the needle tract was also defined as PH herein) in addition to the differences in the patient profiles.

Interestingly, in the study of Görgülü et al., performed on 65 patients, using an 18-G needle, which was also conducted in a Turkish study population, the authors determined the complication rate as 15.4% and the diagnosis rate as 90.8% (17). In a study of transthoracic lung biopsies performed using a 18-G coaxial semi-automatic biopsy needle on 50 lung lesions, PTX was occurred in 3 patients, hemorrhage in 3 patients, and both PTX and hemorrhage complications occurred in 4 patients (18). The higher complication rate and

diagnosis rate in the current study may have been attributed to the use of a thicker needle (16 G). This possible effect may be further tested by using thinner needles and observing the impact of the needle thickness in complication rates in future studies.

This study had some limitations, such as it was retrospective, conducted in a single center, and not randomized. In addition, the post-procedure follow-up of the patients was made by chest radiography up to 4 h post-procedure. Therefore, late complications could not be evaluated. On the other hand, although this study represented our first experiences with CT-guided TTLB, obtaining similar results as the literature was encouraging.

In conclusion, although two major complications, namely PTX and PH, may occur during TTLB, the spontaneous recovery of complications in most patients, the relatively uncommon need for a chest tube in PTX management, and the rare need for additional vascular intervention in PH make TTLB a reasonable option in the diagnosis of lung lesions, even in centers with less experience.

Ethical Approval: The study was approved by the Adıyaman University Non-Interventional Ethics Committee (Approval no: 2020 / 9-32).

Author Contributions:
Concept: M.Ç.
Literature Review: M.Ç., M.G., H.T.B.
Design : M.Ç., B.P.
Data acquisition: M.Ç., Ö.C.G.
Analysis and interpretation: M.Ç., H.A.
Writing manuscript: M.Ç., M.G.
Critical revision of manuscript: H.T.B., B.P., Ö.C.G., H.A.
Conflict of Interest: *None*
Financial Disclosure: *None*

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