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CT-guided transthoracic biopsy: histopathologic results and complication rates

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PURPOSE
We aimed to investigate the effectiveness and complications of transthoracic CT-guided biopsy techniques.

METHODS
A total of 94 CT-guided percutaneous transthoracic biopsy procedures performed in 85 patients were retrospectively evaluated. Core biopsy technique was used in 87 procedures and transthoracic fine-needle aspiration biopsy was used in seven procedures.

RESULTS
Diagnostic results were achieved in 79 of 94 biopsy procedures. Pathology results were malignant in 54 patients, suspicious for malignancy in three patients, benign in five patients, and benign nonspecific in 17 patients. Specific diagnoses were obtained in 59 patients (62.8%) using core biopsy, but no specific diagnosis could be reached with transthoracic fine-needle aspiration biopsy. Complications included pneumothorax in 27 patients (28.7%) and parenchymal hemorrhage during and after the procedure in eight patients (8.5%).

CONCLUSIONS
CT-guided percutaneous transthoracic needle biopsy is a highly accurate procedure for histopathological diagnosis of thoracic masses. In addition, percutaneous transthoracic biopsy has an acceptably low complication rate and it reduces the need for more invasive surgical procedures.

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Since the beginning of the 21st century, lung cancer has been cited as one of the most common causes of death (1). World Health Organization declared lung cancer as the first leading cause of death in men and second in women, among all types of cancers (2).

Percutaneous transthoracic biopsies are performed either using fine-needle aspiration biopsy (transthoracic fine-needle aspiration biopsy, TTFNAB) method or using the incisional or core biopsy method. Incisional biopsy and core biopsy are used to obtain a part of tissue from the lesion for histological diagnosis. On the other hand, TTFNAB is used to obtain aspiration material, which is used for cytological examination and lesion diagnosis (3, 4).

Indications of transthoracic needle biopsy include solitary and multiple pulmonary nodules, mass lesions, persistent focal infiltration, consolidation, presence of cavities and abscesses, pleural lesions, and mediastinal and hilar mass diagnosis (3, 5).

The aim of this study was to investigate the technique, suitability, and complications in CT-guided transthoracic biopsy of lung masses.

Methods

This study was approved by the institutional research ethics review committee. A total of 94 CT-guided percutaneous transthoracic biopsies performed on 85 patients were included in the study. The biopsy procedure was repeated in nine patients due to clinical requirements.

Eighty-seven core and seven TTFNAB procedures were performed under the guidance of a 128-slice CT device (Somatom Definition AS Plus 128, Siemens Healthcare, Forchheim, Germany). The CT images of all cases were analyzed retrospectively. Patients were evaluated according to the localization of biopsy entry site and the parenchymal distance from the pleural surface to the lesion in the biopsy tract.

Prebiopsy preparations

Bleeding time parameters were measured in all patients before the biopsy to ensure that they were within normal limits (prothrombin time, 9.50–14.0 s; activated prothrombin time, 25–35 s; and international normalized ratio, 0.8–1.2). In patients receiving anticoagulants and antiplatelet drugs such as aspirin or coumadin the treatment was discontinued at least five days prior to the procedure. All patients were informed about the purpose and methodology of the biopsy procedure, as well as possible complications such as pneumothorax, hemoptysis, hemorrhage, and the treatment of those complications. Afterwards, written consent for the biopsy was obtained from all patients.

Biopsy procedure

Localization of the mass was determined by CT or positron emission tomography (PET) CT. The shortest and safest parenchyma distance to reach the lesion was determined. The distance of the lesion from the entry point and entry angle were planned and the entry point on the skin was marked by a permanent marker (Fig.). The distance between skin, pleura, and lesion were also measured and recorded.

Marked skin entry site and the surrounding area were cleaned with povidone iodine solution. Skin was covered with sterile drapes exposing only the entry site. Local anesthesia of the skin and subcutaneous tissues was achieved with 5–10 cc of lidocaine HCl. In accordance with the predetermined route, a 17G, 11 cm coaxial needle guide (Matek 17GKN11, Matek medical, Ankara, Turkey) was advanced in the skin until "skin-pleura" distance, and control CT sections were acquired. After ensuring that the route of the needle was in the proper position, it was advanced rapidly to pass through the pleura in one swift move and control CT sections were obtained to confirm the appropriate position of the needle within the lesion. The correct localization of the needle was verified by using the following criteria such as the needle's tip being inside or on the edge of the lesion and seeing linear hypodensity extending peripheral to the needle tip (beam hardening artifact). The inner chuck of coaxial needle guide was removed and an 18G, 16 cm core semi-automatic core biopsy pistol (Matek medical) was placed inside the needle guide. After obtaining the sample, the needle was carefully removed from the cannula and the chuck was reattached. To acquire multiple samples, the needle guide was not removed from the lesion and the material acquisition was repeated by directing the biopsy pistol into appropriate positions at different directions. The materials obtained by core biopsy were put into previously prepared sterile 10% formalin solution. Fine-needle aspiration materials were sprayed onto the slide and were quickly and carefully spread to avoid crushing of the cells and placed into a previously prepared vessel containing 95% ethyl alcohol. Part of the smear samples was allowed to air dry. The biopsy system was withdrawn when sufficient biopsy materials were collected. The needle entry site was sealed with antibiotic ointment and sterile gauze, and axial slices were taken at the biopsy level without lifting the patient. Patient was transferred to observation room, positioned so that the needle entry remained underneath, and followed for two hours for possible complications. Asymptomatic patients with mild pneumothorax were followed with no intervention. Chest tubes were inserted into symptomatic patients and patients with evidence of increasing pneumothorax, based on control postero-anterior chest radiographs or CT scans.

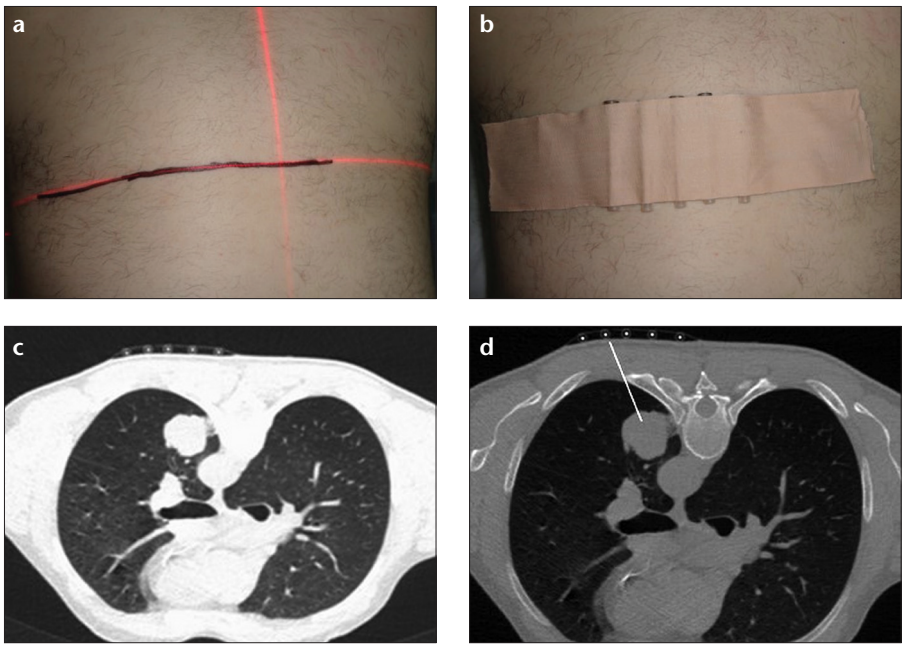

Figure. a–d. Marking of the biopsy entry site on skin and CT images.

Table 1. Patient's age, lesion size, and traversed parenchyma distance

	n	Range	Mean±SD
Age, years	94	26–85	64±10.9
Traversed parenchyma distance, cm	94	0–5	0.61±1.06
Lesion size, cm	94	1.02–11.62	5.22±2.47

Statistical analysis

Fisher's exact test was used to compare the distribution between nominal and ordinal variables. SPSS version 15.0 for Windows (SPSS Inc., Chicago, Illinois, USA) was used for statistical analysis. A P value <0.05 was considered statistically significant.

Results

A total of 85 patients (77 males and eight females) whose pathology results were accessible were included in the study. The patients' mean age was 64.0±10.9 years (26–85 years), mean lesion size was 5.2±2.47 cm, and the median traversed parenchymal distance was 2 cm (range, 0–5 cm) (Table 1).

A total of 94 biopsies, including 87 core biopsies (92.6%) and seven TTFNAB (7.4%) were performed in 85 patients. First biopsy was histopathologically diagnostic in 71 of 85 patients, while nondiagnostic in 14 patients. Six out of 71 patients with diagnostic first biopsy underwent a second biopsy due to nonspecific benign result and unresolved suspicion of malignancy. Three of these patients were confirmed to have a malignant lesion on the second biopsy, whereas the remaining three patients were again determined to have a nonspecific benign pathology. Three out of

14 patients with nondiagnostic first biopsy underwent a second biopsy which yielded a diagnostic sample in two patients, but was again nondiagnostic in the third patient. Thus, in total 73 of 85 patients had successful biopsies yielding histopathological results (Table 2).

A total of 41 complications developed in 38 patients (44.7%) with two patients having more than one complication. The most common complication was pneumothorax, which developed in 27 of 94 biopsy procedures (28.7%). In 17 cases (63%), pneumothorax improved spontaneously without any intervention, while 10 cases (37%) had pneumothorax in more than 20% of their lung volume and were treated by inserting a pigtail catheter with sealed underwater drainage. Eight cases (8.5%) developed mild parenchymal hemorrhage in the needle track and around the lesion, which resolved spontaneously. Four cases (4%) developed hemothorax; one case required treatment using pigtail catheter and underwater drainage, while others were not intervened. Finally, two cases (2%) developed subcutaneous emphysema at the skin entry site. Both cases developing emphysema underwent two sessions of core biopsy. In the first case, minimal subcutaneous emphysema was observed after the first biopsy and the safest way to reach the lesion was determined to be through the minor fissure. In the second case, the distance of the lesion from the chest wall was 1 cm and prominent subcutaneous emphysema was seen six hours after the second biopsy procedure. None of those two cases were intervened for emphysema. However, the second case received treatment for pneumothorax which developed after the first biopsy.

There was no statistically significant association between the type of biopsy procedure and the presence of complications (Table 3). There was, however, a significant relationship between parenchymal hemorrhage and age (P = 0.001), as well as left or right lung localization of the lesion (32.6% left vs. 67.4% right, P = 0.017).

Table 2. Biopsy results

	n (%)
Malignant	57 (60.6)
Benign	22 (23.4)
Nondiagnostic	15 (16)
Total	94 (100)

Discussion

In this retrospective study of CT-guided lung biopsies, diagnostic accuracy rate was 84% (61% malignant, 23% benign). Core biopsy was the preferred biopsy method in the majority of patients. The most common complication was pneumothorax (29%), followed by parenchymal hemorrhage (8%) and hemothorax (4%). Complications were not related to biopsy type.

The type of lung biopsy is usually determined based on the presence of coagulation disorders, lesion size, observations that suggest increased risk of emphysema-like complications near the lesion, and traversed parenchymal distance. Because a cytopathologist is required to assess the adequacy of aspirated during the procedure, TTFNAB is used less frequently and core biopsy is mainly preferred (6, 7). In TTFNAB, the possibility of malignancy cannot be excluded unless there is a diagnosis of a specific benign lesion (6).

Table 3. Results of biopsy type and major complications

	Biopsy type	No	Yes	Total	(%)	*P*
Pneumothorax	Core	62	25	87	28.7	1
	FNAB	5	2	7	28.6	
Parenchymal hemorrhage	Core	80	7	87	8.0	0.475
	FNAB	6	1	7	14.3	
Hemothorax	Core	83	4	87	7.4	1
	FNAB	7	0	7	0	

FNAB, fine needle aspiration biopsy.

Priola et al. (7) evaluated a total of 321 cases of CT-guided TTFNAB where 165 procedures were performed in the presence of an experienced cytopathologist and 156 procedures were evaluated by inexperienced pathology students. Due to insufficient material, fine-needle biopsy was performed for 35 of these patients. The authors reported that cytopathologist should be readily available to assess the adequacy of the sample during CT-guided TTFNAB process, but stated that the reliability of TTFNAB was not significantly affected from the experience of cytopathologists. They also emphasized that the diagnostic value of percutaneous transthoracic biopsies increased significantly with a combined approach, and reported similar diagnostic efficacy for benign and malignant lesions (7). In our study, due to the absence of pathologists during the procedure, core biopsy was applied in the majority of cases and TTFNAB was applied in only seven patients (7.4%). Combined biopsy was not performed due to the retrospective nature of our study and due to the inability of patient planning and inadequate number of patients. In patients that underwent TTFNAB, the histopathological diagnosis could not be achieved in three patients, while pathology results were nonspecific benign in two patients and nonspecific malignant in two patients.

CT-guided percutaneous core needle biopsy is a safe and accurate method, which can even be used in lesions smaller than 10 mm (8). Recently, use of flat detector C-arm cone-beam CT has improved the accuracy of core biopsy even more by allowing real-time needle guidance and easier access to the lesions (9). Loubeyre et al. (6) evaluated 75 patients with a suspected thoracic lesion and emphasized that CT-guided percutaneous core biopsy with large-bore coaxial needles is a safe and accurate method to achieve specific histological diagnosis with low complication rates. In our study, we used a coaxial technique and performed core biopsy with a semi-automatic core biopsy needle in 87 patients (92.6%). The accuracy rate of CT-guided transthoracic biopsy was 95% for malignant lesions and 88% for benign lesions

(10). In our study, diagnostic results were achieved in 79 out of 94 biopsy procedures. A specific diagnosis was obtained in 59 core biopsy procedures (62.8%), while a specific diagnosis could not be reached in any of the patients who underwent TTFNAB. In our study, core biopsies had higher success rates compared to TTFNAB, which is consistent with the literature.

Yeow et al. (11) disregarded the effects of the needle size and determined a considerably lower pneumothorax rate in procedures performed by experienced radiologists. In the same study, the authors showed that cases with a lesion size smaller than 2 cm had increased pneumothorax rates in all procedures performed by the radiologists even though needles thinner than 20G were used. Based on these results, the authors stated that pneumothorax rate was not affected by needle size (11). Similarly, Topal and Berkman (12) found no significant relationship between pneumothorax, needle size, and biopsy type in their retrospective study of 284 cases that underwent transthoracic biopsy. However, other studies reported an increase in the pneumothorax rate with larger needle diameters (13). In our study, we used a 17G 11 cm coaxial needle guide and an 18G 16 cm semi-automatic biopsy needle for core biopsy, while 22G Chiba needle was used for TTFNAB. Therefore, we did not perform statistical analyses between the needle size and development of complications. There was no association between the type of biopsy and pneumothorax. This might be because the same thickness of parenchyma were traversed by coaxial needle in all cases. In addition, the small number of patients who underwent TTFNAB is thought to have affected the statistical dependencies between the type of biopsy and the presence of pneumothorax. We believe that studies with equal number of cases for each procedure type can give more accurate statistical results.

If the pneumothorax is small and asymptomatic it usually resolves by spontaneous absorption. Meanwhile, progressive cases of pneumothorax are treated by inserting a pigtail catheter. In our study, 17 patients (63%) with pneumothorax improved by spontaneous absorption. However, 10 (37%) patients who had pneumothorax in more than 20% of lung volume were treated by inserting a pigtail catheter. In cases where pneumothorax develops during the procedure, manual aspiration can be done by inserting a different needle through a needle guide or into the pleural space (14). Also, development of pneumothorax can be avoided by the "patching technique", where the air leakage is reduced by closing the biopsy tract with 2–3 mL injections of patient's own blood or fibrin tissue sealant when withdrawing the needle (12, 14). The biopsy tract can also be sealed by dripping 3–4 mL of 0.9% NaCl solution when withdrawing the needle guide (15). Another effective maneuver is to lay the patient down after the biopsy so that the puncture site will be underneath him or her. In our study, we asked patients to lie directly on the puncture site and followed them carefully.

The second most common complication observed in percutaneous transthoracic biopsy is parenchymal hemorrhage with an incidence of 5%–10% (11, 14, 16). In our study, eight patients (8.5%) developed parenchymal hemorrhage, which is consistent with the literature. Yeow et al. (11) suggested that using a fine-needle biopsy would be much safer if pleural effusion was present. In our study, four patients developed hemothorax and two patients developed subcutaneous emphysema after the procedure.

Limitations of our study include the retrospective study design, small number of TTFNAB patients due to difficulties in planning more TTFNAB procedures together with pathologists, and small number of evaluated parameters.

In conclusion, CT-guided percutaneous transthoracic core biopsy is effective in obtaining histopathological diagnosis of lung masses. It has high accuracy and acceptably low complication rates with risks known in advance, which can be prevented. In addition, percutaneous transthoracic biopsy is a reliable method that reduces the need for more invasive surgical procedures.

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Conflict of interest disclosure

The authors declared no conflicts of interest.

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