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Transthoracic lung and mediastinal biopsies obtained with the Tru-Cut technique: 10 years' experience

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Aim: Percutaneous needle biopsy has been used successfully in many organ systems with excellent results and few complications. In this study, we sought to evaluate percutaneous transthoracic biopsy results using a coaxial system.

Materials and methods: The records of 302 patients (mean age, 63.1 years) who underwent percutaneous CT-guided coaxial cutting needle lung and mediastinal biopsy were retrospectively evaluated. Number, diameter, location of the lesions, calcification, and emphysema on lung parenchyma were noted. The number of specimens obtained, complications after the procedure, and treatment of complications were recorded.

Results: From lesions identified in 270 patients on thoracic CT, a mean of 5.6 biopsy specimens were obtained in 1 procedure. Pathology results of transthoracic biopsies were achieved in 258 patients (95.5%), of whom 226 (87.5%) were diagnostic. At the final diagnosis, 178 biopsy results (68.9%) demonstrated malignancy. Complications were observed in 68 patients (25.1%). No relationship of age, sex, presence of emphysema on lung parenchyma, or the number of biopsy specimens obtained with the development of complications was observed.

Conclusion: Transthoracic lung and mediastinal biopsy using a coaxial system is a well tolerated, minimally invasive procedure that has a high diagnosis rate, provides reliable differentiation of malignant and benign lesions, and has an acceptable rate of complications.

Key words: Tru-Cut lung biopsy, lung lesions, pneumothorax

Tru-Cut tekniği kullanılarak alınan transtorasik akciğer ve mediastinal biyopsiler: 10 yıllık deneyim

Amaç: Perkütan iğne biyopsileri düşük komplikasyon ve yüksek tanı oranları nedeniyle organ patolojilerinin çoğunda başarıyla uygulanmaktadır. Çalışmamızda coaxial sistem kullanılarak yapılan transtorasik biyopsi sonuçlarını değerlendirmeyi amaçladık.

Yöntem ve gereç: Perkütan BT-aracılı coaxial akciğer ve mediastinal biyopsi yapılan 302 hasta (ortalama yaş, 63,1 ± 13,2 yıl) retrospektif olarak incelendi. Lezyon sayısı, çapı, lokalizasyonu, kalsifikasyon içerip içermediği ve akciğer parankiminde amfizem varlığı kaydedildi. İşlem sırasında alınan örnek sayısı, komplikasyon gelişimi ve komplikasyonların tedavisi not edildi.

Bulgular: Toraks BT'de lezyon saptanan 270 hastadan işlem sırasında ortalama 5.6 biyopsi alınmıştı. Transtorasik biyopsi yapılan hastalardan 258 (% 95.5)'inin patoloji sonucuna ulaşılabildi ve 226 (% 87,5)'sı tanısal olarak değerlendirildi. Bu çalışmada, 178 (% 68,9) hastanın biyopsi sonucu malignite ile uyumlu idi. Hastalardan 68 (% 25,1)'inde komplikasyon saptandı. Komplikasyon gelişimi ile yaş, cinsiyet, amfizem varlığı ve biyopsi sayısı arasında ilişki saptanmadı.

Sonuç: Coaxial sistem kullanılarak alınan transtorasik akciğer ve mediastinal biyopsiler yüksek tanı oranları ve düşük (kabul edilebilir) komplikasyon oranlarına sahiptir.

Anahtar sözcükler: Perkütan akciğer biyopsisi, akciğer lezyonları, pnömotoraks

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Introduction

Bronchoscopic and percutaneous lung biopsies are commonly used for specific cytologic and histopathologic diagnoses of pulmonary lesions. The diagnostic accuracy of flexible bronchoscopy is high for centrally located lesions. However, its diagnostic value for peripherally located lesions is lower (1). When bronchoscopic methods are insufficient, transthoracic lung biopsy is commonly used for histologic diagnosis and classification of lesions. Reasons for performing percutaneous lung biopsy include diagnosing primary and metastatic malignancies and benign lesions, obtaining a specimen for culture, and performing other microbiologic tests.

For diagnosis of focal lung lesions, percutaneous coaxial cutting needle lung biopsy guided by computed tomography (CT) has been accepted as an initial method (2). Compared with fine needle aspiration, cutting needle biopsy provides better diagnostic accuracy of benign lung lesions and a similarly high degree of diagnostic accuracy of malignant lung lesions, with acceptably low risks and no need for an on-site cytology team (3). Diagnostic accuracy rates for cutting needle lung biopsy have been reported as ranging from 76% to 93% despite the use of a standard CT-guided coaxial technique (2).

Percutaneous needle biopsy has been successfully applied in many organ systems with excellent results and few complications (4). In this retrospective study, we sought to evaluate percutaneous transthoracic biopsy results.

Materials and methods

From November 1996 to June 2007, percutaneous transthoracic CT-guided coaxial cutting needle biopsy procedures were performed in 302 patients. The records of these patients were retrospectively evaluated. Of the 302 subjects, 32 were excluded from the analysis because their records were not available since they had been referred from other centers only for the biopsy procedure. All patients who underwent percutaneous transthoracic lung biopsy had focal lung lesions presenting as a nodule, a mass, or a mass like consolidation. Thoracic CT scans of 270 patients were examined. The number, diameter, and location (central, peripheral, and mediastinal) of the lesions as well as the presence or absence of calcification and emphysema on lung parenchyma were noted. Radiologically, lesions that were located proximal to the segment bronchus were defined as *central,* and those located distal to segment bronchus were accepted as *peripheral*. Lesion size was measured along the maximum long axis diameter. Prior to percutaneous lung biopsy procedures, platelet counts, prothrombin time, and activated thromboplastin time of all the participants were recorded. Detailed information including the necessity of the procedures, how the procedures would be performed, possible complications, and how these complications would be treated were explained to each subject. Written informed consent was obtained from all patients. All biopsies were performed by 2 interventional radiologists. The study protocol was approved by the local research ethics committee.

Patients were positioned on the tomography table and were aligned in the best position with regard to the lesion location; slice images of 3 to 5 mm were obtained. Metallic signs were placed on the skin to define the exact insertion site. After appropriate cleaning and sterilization of the skin, local anesthesia was applied, and a small incision was made to facilitate passage of the needle. A 16-G needle at an appropriate angle to the lesion was inserted. During the biopsy procedure, a removable hub system (vanSonnenberg, Cook Bjaeverskov, Denmark) was used. This system is composed of a 19-G outer cannula, a 22-G inner cannula containing a removable hub, and a 23-G mandrel. The 22-G needle with its mandrel passing through the 16-G needle was placed into the lesion. After CT images had confirmed that the 22-G needle was correctly positioned into the lesion, the hub of 22-G needle and the mandrel were removed. After removal of the 16-G needle, using the 22-G needle as guidewire, the 19-G outer cannula was placed at the edge of the lesion. Using a 21-G Autovac biopsy needle (Bard, Karlsruhe, Germany) through the 19-G cannula, Tru-Cut biopsies were obtained. At the end of the biopsy procedure and 1 h after the procedure, control thoracic CT scans were obtained. If a pneumothorax was detected, air in the pleural space was aspirated while withdrawing the cannula. If patients had no symptoms and no increase in the pneumothorax on follow-up, no intervention was performed. If aspiration was inadequate or if a large or rapidly enlarging pneumothorax was found, a chest tube was placed into the pleural space. The tubes used were of various types of locking loop pigtail catheters (usually 8 or 10 F). A pleural catheter was inserted for water drainage and kept in place for at least 24 h. If the pneumothorax resolved, the chest tube was removed and the patient was discharged. Obtained specimens were put in a solution containing formalin and sent to the pathology laboratory for analysis and in isotonic saline for culture.

Patients with abnormal clotting function, thrombocytopenia, suspected hydatid cyst or arteriovenous malformation, mechanical ventilation that could lead to pneumothorax or air embolism, inability to suspend respiration or control cough on request, and those who could not tolerate a recumbent position were excluded.

The number of specimens obtained and complications (pneumothorax, bleeding, hemoptysis, etc) after the procedure were noted. Interventions to treat complications were recorded. Transthoracic biopsy results were classified into 3 groups: malignant, benign, and nondiagnostic results.

Data analyses

Statistical analyses were performed with SPSS (version 10.0, SSPS Inc, Chicago, IL, USA). Continuous variables are presented as means ± standard deviation, and differences between patients were evaluated with the unpaired t test. Categorical variables are reported as group percentages. The chi-square test was used to compare categorical variables. All P values are 2-sided, and values <0.05 were considered statistically significant.

Results

Transthoracic biopsy using a coaxial system was performed on 302 patients. Complete records were available in 270 patients. The mean age of the patients was 63.1 ± 13.2 years; 68 (25.2%) were female and 202 (74.8%) were male. With regard to the number of lesions on CT, there were 165 (61.1%) single lesions, 2 lesions in 24 patients (8.8%), and multiple lesions in 81 patients (30.1%). The mean number of lesions was 2.3, and the mean long axis diameter was 40.2 ± 21.4 mm. Calcification and emphysema were noted in 13 (4.8%) and 72 (27.6%) patients, respectively. The locations of the lesions on thoracic CT are presented in Table 1.

Table 1. Localization of the lesions on Thorax CT.

Localization	**n**	**%**
Central	32	12.2
Peripheral	165	63.0
Mediastinal	35	13.4
Central + Peripheral + Mediastinal	38	11.4

Pathology results of transthoracic biopsy were achieved in 258 patients (95.5%), of whom the results were diagnostic in 226 (87.4%). At the final diagnosis, the biopsy results were malignant in 178 patients (68.9%) and they were benign in 48 patients (18.5%). The pathology results were nondiagnostic in 32 patients (12.6%). In 12 patients (4.4%), a pathology result was not available in the patient records. Biopsy results are presented in Table 2.

From lesions identified on thoracic CT, a mean of 5.6 biopsy specimens were obtained from each patient. In 1 patient with severe emphysema, pneumothorax developed on our first attempt, and thus a biopsy specimen could not be obtained. Complications were observed in 68 (25.1%) of 270 patients in whom a transthoracic biopsy was performed. Pneumothorax developed in 59 patients (21.8%); a drainage tube was needed in 22 of them. A pigtail catheter was used for tube drainage, after underwater seal drainage in all of the patients, the pneumothorax resolved and surgery was not needed. In patients with bleeding and hemoptysis, no additional therapeutic intervention was needed on follow-up. The complications observed after transthoracic biopsy and therapy for these complications are summarized in Table 3.

With regard to complications, age, sex, emphysema on lung parenchyma, and the number of biopsy specimens obtained had no effect on the development of complications (P > 0.05 for all). Complications were noted in 28% of the males and

Table 2. Histopathologic findings for 258 transthoracic biopsy.

	n	%
Malignant Lesions	**178**	**68.9**
Small cell lung cancer	12	4.7
Non-small cell lung cancer	42	16.3
Adenocarcinoma	53	20.5
Squamous cell carcinoma	12	4.7
Large cell carcinoma	1	0.3
Carcinomas	40	15.5
Metastatic lung carcinomas	8	3.1
Solitary fibrous tumors	1	0.3
Thymoma	3	1.3
Thymic carcinoma	1	0.3
Anaplastic cells	1	0.3
Atypical cells	2	0.8
Lymphoma infiltration	2	0.8
Benign Lesions	**48**	**18.5**
Granulomatous reaction	14	5.4
Chronic inflammation	5	1.9
Acute inflammation	8	3.1
Aspergilloma	4	1.5
Lymphoid tissue	2	0.8
Plasma cell granuloma	2	0.8
Reactive mesothelial cells	1	0.3
Hydatid cyst	2	0.8
Interstitial fibrosis	6	2.3
Hyalinized tissue	3	1.3
Rheumatoid nodule	1	0.3
Nondiagnostic results	**32**	**12.6**
Necrosis	7	2.7
Blood components	6	2.3
Lung parenchyma	6	2.3
Bronchial tissue	4	1.5
Benign cells	3	1.2
Cartilage tissue	3	1.3
Anthracosis	3	1.3

Table 3. Complications and treatments after transthoracic lung biopsy.

	n	%
Pneumothorax	57	21.1
observation	*35*	*61.4*
Tube drainage	*22*	*38.6*
Bleeding	7	2.6
observation	7	100
Hemoptysis	2	0.7
observation	2	100
Pneumothorax and bleeding	2	0.7
observation	2	100

16.4% of females (P > 0.05). Location of the lesion (peripheral, central, or mediastinal) did not affect the complication rate (P > 0.05). When the lesions were classified according to diameter as <2 cm, 2-3 cm, and >3 cm, the rates of complications were 28.3%, 33.3%, and 21.1%, respectively; no significant difference was detected among these subgroups (P = 0.1). The complication rate was significantly higher in calcific lesions than in lesions without calcification (53.8% vs. 23.3%; P = 0.02). Complications were seen in 19 (26.4%) of 72 patients with emphysema. No differences were detected in complication rates between benign and malignant lesions (24.3% vs. 24.2%, respectively; P > 0.05).

Discussion

Since it is not always possible to obtain adequate specimens by fine needle aspiration biopsy for histologic diagnoses, a Tru-Cut biopsy technique is commonly used for many solid organ lesions. Although the fine needle aspiration biopsy technique has a high sensitivity for diagnosing malignant lesions, a biopsy obtained using a coaxial system has the advantage of defining the specific subtype of the lesion.

Needles are divided into 2 broad categories, aspiration needles for cytology and cutting needles for histology samples. Large tissue cores are obtained with a powered Tru-Cut needle with throw lengths of

1 to 2 cm and variable throw options. The widely used coaxial system (which consists of inserting a thin inner needle through a larger outer needle placed at the edge or within the lesion) has numerous advantages over the single needle technique including limiting the number of pleural punctures, a reduced pneumothorax rate, and the opportunity to obtain multiple specimens.

CT-guided coaxial cutting needle biopsy has been used as an initial method for transthoracic biopsy of focal lung and mediastinal lesions. Recently coaxial models with small diameters have become available allowing multiple core specimens with a single pleural puncture (5). Yeow and colleagues reported that they obtained 3 specimens on every biopsy procedure with 95% overall diagnostic accuracy and diagnostic accuracy rates of 99% and 86% for malignant and benign lesions, respectively (6). A larger and a more recent study on this topic by Hiraki et al, which included 901 patients and 1000 lesions, provided very high diagnostic yields of CT guided coaxial technique (7). The overall diagnostic accuracy was 95.2%. In only 6 lesions (0.6%) the biopsy results were nondiagnostic. Independent predictors of diagnostic failure were identified as obtaining 2 or less specimens, lesions in the lower lobe, malignant lesions and small lesions with a diameter of 1 cm or less.

In the present study, the mean number of specimens obtained in 1 attempt was 5.6, and the rate of reaching a diagnosis was 87.4%. This ratio is in accordance with the literature. These findings demonstrate that using an appropriate method with an adequate number of specimens provide high diagnostic rate of the procedure.

In diagnosing pulmonary carcinoma, histology offers no advantages over fine-needle aspiration. Nevertheless, cutting needles have been shown to be more accurate in diagnosing benign lesions and lymphomas and when an on-site cytopathologist is absent (8). In the present study, lymphoma was diagnosed in 2 patients by cutting needle lung biopsy. In 2 patients with hydatid cysts, since the lesion looked like a solid mass lesion on thoracic CT and there was no history or clinical signs of cystic disease, a transthoracic lung biopsy was performed. In one patient rheumatoid nodule was also demonstrated by Tru-Cut needle biopsy. We think that, by obtaining sufficient histologic specimens, the diagnosis can be achieved in such situations. In 12.6% of our subjects, biopsy specimens were not diagnostic. It was thought that this might have resulted from sampling mistakes, the inability to reach a small lesion, or taking the specimens from the necrotic core or a peritumoral fibrotic-inflammatory area.

Percutaneous biopsy of mediastinal or hilar lymph nodes (to diagnose lung carcinoma) or enlarged lymph nodes (to detect mediastinal invasion) is less invasive than mediastinoscopy. CT-guided coaxial cutting needle biopsy is safe; however, pneumothorax and bleeding are the 2 most frequently encountered complications. Pneumothorax remains the most common complication of CT-guided lung biopsy. A review of the existing literature reveals variable rates of pneumothorax from 8% to 64% (9). This large range for pneumothorax reflects both altered risk from the location of the lesion and the increased sensitivity of CT. A recent study by Yildirim et al. revealed an overall complication rate of 39.1% (10). Pneumothorax was the most common complication developed in 26% of the cases, most of which were mild (18.6%). No single factor was found to be an independent predictor of the development of pneumothorax. Bleeding was the second most common complication in that study and lesion size rather than lesion depth was identified as a predictor of it. It has been reported that the rate of pneumothoraces requiring treatment with chest tube varies from 1.6% to 17% of the patients (3). When pneumothorax is detected following biopsy, management options include observation, aspiration, or chest tube drainage. British Thoracic Society guidelines on managing pneumothorax suggest initial treatment by aspiration, with subsequent drainage if a leak and significant pneumothorax persist; a small gauge drain is usually adequate (11). In patients with a large, symptomatic, and progressive pneumothorax, usually a small bore chest tube is enough. Aspiration of the air remaining after the procedure decreases the need for placing a tube.

Yeow and associates reported that compared with lesions with a diameter >4.1 cm, those with a diameter of < 2 cm had an 11-fold increased risk of leading to a pneumothorax. With respect to location, lesions located near the pleura had higher rates of pneumothorax (12). Other research has shown that a perihilar biopsy also is more likely to cause pneumothoraces because of the distance of lung crossed (13). In our study, when the patients were divided according to diameter of the lesion, no significant differences were observed among the 3 subgroups. We found that 59 of 270 patients (21.8%) had a pneumothorax; in 2 of these patients, bleeding was also detected. In 37 cases of pneumothorax, following aspiration of the air in the pleural space via a catheter, no increase in pneumothorax was detected, and no further followed-up was required. However, in 22 patients (38.6%), a pigtail chest tube was inserted owing to an increase in the pneumothorax; on follow-up, the pneumothorax regressed and no surgical intervention was required. The rate of pneumothorax in our study is in accordance with previous reports. We think that aspiration of the air in the pleural space decreases the need for a chest tube insertion.

Chronic obstructive pulmonary disorder and hyperinflation; the size, depth, and location of the lesion; a small angle of the needle with the thoracic pleura; repositioning the needle multiple times; and, numerous samples are among the risk factors associated with increased risk of pneumothorax (14). In the present study, location and size of the lesion, the number of the biopsy specimens, and presence of emphysema were not found to significantly affect the complication rate.

Hemorrhage, most often a self-limiting complication, is the second most common and potentially most dangerous complication of percutaneous biopsy. Hemorrhage occurs in approximately 5% to 16.9% of patients undergoing percutaneous biopsy. Hemoptysis occurs in 1.25% to 5% in most series and is slightly more frequent when cutting needles are used (15,16). Intrapulmonary hemorrhage may occur with or without hemoptysis. Massive hemoptysis requiring bronchoscopic tamponade, arterial embolization, or surgery has become extremely rare with small caliber needles. Lesion depth has been identified as the most important risk factor for hemorrhage, with an increased risk of bleeding in lesions deeper than 2 cm. Hemorrhage was detected in 9 of our patients (3.3%). In 2 patients, hemoptysis was noted, both were nonmassive. In all of these patients, the bleeding stopped spontaneously, so no intervention or blood transfusion was needed. There was no relationship between lesion location and bleeding. The lower rate of hemorrhage might be due to the use of fine needles and the biopsy technique.

Mortality from transthoracic lung biopsy is generally an early event. The mortality rate of percutaneous biopsy has been estimated globally as being 0.002% of all patients, mainly due to systemic air embolism, pericardial tamponade, and acute massive hemoptysis (3). No death occurred in our study population.

In conclusion transthoracic biopsy using a coaxial system is a well tolerated, minimally invasive procedure, with a high rate of diagnosis, providing reliable differentiation of malign and benign lesions, with acceptable complication rates and high diagnosis rate. It is a feasible procedure for focal lung lesions.

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