CT-GUIDED TRANSTHORACIC BIOPSY: FACTORS IN PNEUMOTHORAX RISK AND DIAGNOSTIC YIELD

Bilgin Kadri Arıbaş MD, Gürbüz Dingil MD, Gürsel Şahin MD, Kamil Doğan MD, Emel Yücel MD, Ümit Üngül MD, Dilek Ünlü MD, Zekiye Şimşek MD, Pelin Demir MD

Department of Radiology, A.Y. Ankara Oncology Training and Research Hospital, Ankara, Turkey

ABSTRACT

Objective: *To evaluate the effective factors in risk of pneumothorax and diagnostic yield in CT-guided transthoracic needle biopsy.*

Material and Method: *CT-guided lung biopsies performed on 260 patients were retrospectively evaluated. Forty-one thick needle biopsies and 219 fine needle aspiration biopsies (FNAB) were performed. Pneumothorax was observed in 23 patients (8.8%) and hemorrhage in 4 patients (1.5%). Pneumothorax was treated with manual aspiration in 3 patients (1.2%) and with placement of a chest catheter in 5 patients (1.9%). The etiologies of pneumothorax and diagnostic accuracy were analyzed with both univariate and multivariate analysis.*

Results: *The lesion depth and ≤2 cm size were found to be poor predictors of pneumothorax because p values were 0.008 and 0.010 in univariate analysis, but 0.349 and 0.072 in multivariate analysis. Difference due to the depth was rather caused by whether the lesion was pleural or not. Only predictor was ≤2 cm lesion size in nondiagnostic yield (univariate p=0.033 and multivariate p=0.036). Sensitivity, specificity and accuracy rates were 79.2%, 100%, 81.5% respectively.*

Conclusion: *The lesion depth and ≤2 cm size were detected to be poor predictors at pneumothorax. Pneumothorax rates were especially related to whether the lesion was pleural or not. Lesion size ≤2 cm was found to be only predictor regarding nondiagnostic yield.*

Key Words: *CT-guided, lung biopsy, transthoracic biopsy, pneumothorax, hemorrhage.* ***Nobel Med 2011; 7(1): 37-41***

BT EŞLİĞİNDE TRANSTORASİK BİYOPSİ: PNÖMOTORAKS RİSKİ ve TANISAL DEĞERİ

ÖZET

Amaç: BT eşliğinde transtorasik iğne biyopsisindeki pnömotoraks etkenlerini ve tanısal doğruluğu değerlendirmek.

Materyal ve Metod: BT eşliğinde akciğer biyopsisi gerçekleştirilen 260 hasta retrospektif olarak değerlendirildi. 41 kalın iğne biyopsisi ve 219 ince iğne aspirasyon biyopsisi (İİAB) uygulandı. Yirmi üç hastada (%8,8) pnömotoraks ve 4 hastada (%1,5) hemoraji görüldü. Pnömotoraks, 3 hastada (%1,2) manuel aspirasyonla ve 5 hastada (%1,9) toraks tüpüyle tedavi edildi. Pnömotoraks ve doğruluğun nedenleri, hem univariyat hem de multivariyat analizle araştırıldı.

Bulgular: Sırasıyla elde ettiğimiz p değerleri univariyat analizde 0,008 ve 0,010 iken multivariyat analizde 0,349 ve 0,072 olduğundan, lezyon derinliği ve ≤2 cm boyut, pnömotoraksta zayıf prediktörler olarak bulundu. Derinliğe göre fark, daha çok lezyonun plevral olup olmamasından kaynaklandı.

Doğrulukta ise tek prediktör, ≤2 cm boyut olarak bulundu (univariyat p=0,033 ve multivariyat p=0,036). Sırasıyla, hassasiyet, özgüllük ve doğruluk oranları, %79,2, %100 ve %81,5 idi.

Sonuç: Lezyon derinliği ve ≤2 cm boyut, pnömotoraksta zayıf prediktörler olarak bulundu. Pnömotoraks oranları, özellikle lezyonun plevral olup olmamasına bağlıydı. Yanlış tanı ile ilgili tek prediktör, ≤2 cm lezyon boyutu olarak bulundu.

Anahtar Kelimeler: BT eşliği, akciğer biyopsisi, transtorasik biyopsi, pnömotoraks, hemoraji. **Nobel Med 2011; 7(1): 37-41**

INTRODUCTION

Computed tomography (CT)-guided transthoracic needle biopsy is a widely accepted procedure for diagnosing intrathoracic lesions.[1] Because, accuracy for the diagnosis of benign and malignant diseases is higher than 80% and 90%, respectively.[2]

Pneumothorax is the most common complication of transthoracic needle biopsy.[1-9] However small number of patients may require chest tube insertion.[3] Massive hemoptysis, hemothorax, air embolism, malignancy seeding along the needle track and other major complications have been reported, but fortunately, they are very rare.[2]

The reported accuracy of CT-guided biopsies for pulmonary lesions vary.[1,4] Also, factors affecting pneumothorax are various in the studies.[1-9] The diagnostic accuracy and the frequency of pneumothorax in CT-guided transthoracic needle biopsy are affected by many factors; including lesion size, depth, and number of needle passes.[4] There is ongoing debate in the literature for this respect, so we have investigated the factors by univariate and multivariate analysis in this series. The purpose of this study was to evaluate factors affecting risk of pneumothorax and diagnostic yield related to CT-guided transthoracic needle biopsy.

MATERIAL and METHOD

Between November 2004 and April 2007, 301 CT-guided lung biopsies were performed on 260 patients (55 female, 205 male, average age 58.2±11.6, range between 19-84 years). Of them, 41 were repeat biopsies which were excluded from the study: 37 had once repeated biopsy (27 true, 9 false, and one missing), while 4 had second repeated biopsy (all true). One hundred and seventy-six of the lesions were peripheral, 35 central, and 49 central-peripheral. Needle sizes were between 16-22 G, with fine needles ≥20 G and thick needles ≤18 G. Forty-one thick needle biopsies (30 trucut sampling with spring loaded half-automated type needles and 11 with other needles) and 219 fine needle aspiration biopsies (FNAB) with Chiba or Westcott type needles were performed. Approach positions were prone in 68, lateral in 26, and supine in 166 patients.

All procedures were performed by a staff radiologist and a radiology resident. Informed consent was obtained before each biopsy. All biopsies were taken under CT guidance by using a 4-slice HiSpeed QXI (GE Medical Systems). On pre-biopsy CT, the mean size of the lesion, lesion depth, lesion margin and location, and presence of emphysema were recorded. The depth of lesion was accepted as the amount of aerated lung traversed by the needle from the pleura to the proximal margin of the lesion on the biopsy. Smooth margin was seen in 156 lesions (60%), whereas irregular or spiculated margin was in 104 lesions (40%). In 115 patients, lesions were adjacent to pleura. Emphysema was detected in 31 patients by a staff radiologist in the lobe of the lesion in which the biopsy was performed on 1.25-mm CT slices. Emphysema was accepted positive if a bulla and/or low attenuation area with →

lack of vascular structures was found in this lobe.

CT was obtained to check the presence of pneumothorax or hemorrhage immediately after the biopsy. Hemorrhage or bleeding was accepted to be present if a new density on CT slices was more than 1 cm of thickness along the needle tract or around the lobe in which the biopsy was performed. Pneumothorax was observed in 23 patients (8.8%) and hemorrhage in 4 patients (1.5%). All patients with hemorrhage had CT findings and minor hemoptysis. Patients were laid on a stretcher at puncture-site-down position at least for 30 minutes. The patients were discharged if pneumothorax was not present. Routine oxygen was administered by a nasal cannula (100% at 2-4 L/min) to 23 patients who developed pneumothorax. No other treatment was needed in 15 of 260 patients (5.8%) with small (<20%) pneumothorax. It was drained with manual aspiration via an 18- or 20-G intravenous catheter, three-way stopcock, and 50 ml injector in 3 of 260 patients (1.2%) with moderate (20-30%) pneumothorax. A control chest radiograph was obtained while the patient in erect position at 2 hours after the procedure. An enlarging (>30%) or symptomatic or large (>30%) pneumothorax was treated with placement of a chest tube and patient hospitalization in 5 of 260 patients (1.9%).

After the procedure, lesion depth, needle size, number of pleural passes, whether pneumothorax and/or hemorrhage was present, drainage type (either manual aspiration or chest tube) were routinely recorded. Also, the cytopathological results of biopsies and follow-up results were reviewed from the patients' files or electronic recording system (poliklinik© program), thereafter. Size variable was a scale variable, also we divided groups due to 2 cm size cut-off, the same as described by Ohno et al.'s study.[4] Variables were age (scale), ≤2 cm and >2cm size groups, lesion size and depth (scale), pleural relation, emphysema, number of pleural passes, needle size, hemorrhage, and lesion margin.

True positive lesions were diagnosed with malignant/atypical cells if this was confirmed with surgery or in the lesion suggesting malignancy at follow-up. True negative lesions were benign cytopathological diagnosis if this was confirmed with surgery or in stabile or decreasing of the lesion size. Conversely, false positive and false negative were nondiagnotic yield. Inadequate specimen or blood was accepted as false negative diagnosis.

The relationship of the variables with the rates of pneumothorax and diagnostic accuracy was analyzed by univariate analysis using Student-t and Chi-square test and by multivariate test using logistic regression analysis. It was significant if p value was <0.05.

Table 1: Variables affecting pneumothorax development in 260 patients

Variable		No pneumothorax	Pneumothorax	p value[a] p value[b]
Age (years)		58.5±11.4[c]	55.4±12.8	0.153 0.364
Groups due to lesion size	>2 cm	210 (92.9)[d]	16 (7.1)	0.010 0.072
	≤2 cm	27 (79.4)	7 (20.6)	
Mean size (cm)		4.3±2.0	3.8±2.1	0.217 0.563
Pleura-to-lesion depth (cm)		1.8 ±2.2	3.4±2.9	0.008 0.349
Pleural	Pleural	111 (96.5)	4 (3.5)	0.007 0.287
	Nonpleural	126 (86.9)	19 (13.1)	
Emphysema	Negative	210 (91.7)	19 (8.3)	0.397 0.399
	Positive	27 (87.1)	4 (12.9)	
Number of passes	1	199 (91.7)	18 (8.3)	0.549 0.578
	2	24 (85.7)	4 (14.3)	
	>2	14 (93.3)	1 (6.7)	
Needle size	Thick (≤18G)	40 (97.6)	1 (2.4)	0.115 0.550
	Fine (≥20G)	197 (90.0)	22 (10.0)	
Hemorrhage	No	233 (91.0)	23 (9.0)	0.530 0.774
	Yes	4 (100)	0	
Margin	Smooth	144 (92.3)	12 (7.7)	0.422 0.692
	Irregular	93 (89.4)	11 (10.6)	

[a] Univariate p value
[b] Multivariate p value was accepted as predictor if it was <0.05
[c] mean±2SD
[d] Numbers in parentheses are percentages

RESULTS

Variables affecting pneumothorax development are shown in Table 1. The lesion depth and ≤2 cm size were found to be poor predictors of pneumothorax because p values were 0.008 and 0.010 in univariate analysis, but 0.349 and 0.072 in multivariate analysis. There were 115 lesions touching the pleura, of which pneumothorax developed in 4 patients (3.5%). Pneumothorax developed in 19 of 145 non-pleural lesions (13.1%), increasing by a factor of 3.7 for these lesions (p=0.007). But, there was found no relationship between pneumothorax and lesion depth except pleural lesions (p=0.618).

Diagnostic accuracy was investigated in 233 patients obtained a pathologic diagnosis. In these patients, mean diameter of the lesions was 4.3±2.0 cm and mean lesion depth of them was 1.9±2.3 cm.

Variables affecting diagnostic accuracy are shown in Table 2. Single predictor was ≤2 cm lesion size in nondiagnostic yield (univariate p=0.033 and multivariate p=0.036). Of 233 patients, 200 were malignant patients (85.8%) and 33 were benign →

Table 2: Variables affecting diagnostic accuracy in 233 patients

Variable		Diagnostic	Nondiagnostic	p value[a] p value[b]
Age (years)		58.9±10.9[c]	55.7±14.4	0.177 0.215
Groups due to lesion size	>2 cm	169 (83.7)[d]	33 (16.3)	0.033 0.036
	≤2 cm	21 (67.7)	10 (32.3)	
Mean size[e] (cm)		4.2±1.9	4.4±2.4	0.743 0.241
Pleura-to-lesion depth[f] (cm)		1.9±2.3	2.0±2.8	0.640 0.976
Pleural	Pleural	87 (82.9)	18 (17.1)	0.640 0.976
	Nonpleural	103 (80.5)	25 (19.5)	
Emphysema	Negative	162 (79.8)	41 (20.2)	0.075 0.158
	Positive	28 (93.3)	2 (6.7)	
Number of passes	1	158 (81.4)	36 (18.6)	0.840 0.604
	2	22 (84.6)	4 (15.4)	
	>2	10 (76.9)	3 (23.1)	
Needle size	Thick (≤18G)	33 (86.8)	5 (13.2)	0.358 0.322
	Fine (≥20G)	157 (80.5)	38 (19.5)	
Margin	Smooth	109 (81.3)	25 (18.7)	0.926 0.950
	Irregular	81 (81.8)	18 (18.2)	

[a] Univariate p value
[b] Multivariate p value was accepted as predictor if it was <0.05
[c] mean±2SD
[d] Numbers in parentheses are percentages
[e] Mean lesion diameters in malignant and benign lesions were 4.4±2.0 cm and 3.5±1.7 cm, respectively
[f] Mean lesion depths in malignant and benign lesions were 2.0±2.4 cm and 1.6±2.3 cm, respectively.

patients (14.2%). 164 of 200 malignant (82.0%) and 26 of 33 benign patients (79.8%) were correctly diagnosed. Accuracy was not different between benign and malignant lesions (p=0.659). No false positive case was found. True positive, true negative and false negative numbers were 164, 26, and 43, respectively. So, sensitivity, specificity, and accuracy rates were 79.2% (164/207), 100% (26/26), 81.5% (190/233), respectively.

DISCUSSION

The reported rates of pneumothorax in transthoracic needle biopsy range from 8 to 61% in the literature.[3] Our pneumothorax rate of 8.8%, and chest tube drainage of 21.7% in the patients with pneumothorax, are within the range of the previous series.

Conflicting results have been reported concerning the risk factors for the development of pneumothorax.[2] In the published reports, factors that have been associated with a higher risk of pneumothorax include the presence of obstructive airways disease or emphysema, increased depth and decreased size of the lesion, increased outer diameter of biopsy needle, a small angle of the needle with the thoracic pleura, increased number of times that the pleura is traversed, advanced patient age and duration of the procedure.[2] Different variables were significantly observed for pneumothorax rate in various series.[1-11] Because, there were some technique and method differences. The pleura-to-lesion depth and emphysema have been the significant variables in some series.[3] It has been thought that although there is close relationship between depth of lesion and presence of emphysema and pneumothorax, this does not mean that these factors increase the possibility of an occurrence of pneumothorax.[10]

There is still substantial disagreement about the correlation of pneumothorax rate and the length of intrapulmonal biopsy path.[5] Several reports show depth of the lesion to be one of the most important factors in the development of pneumothorax in transthoracic biopsies.[9] In contrast, Yeow et al. reported that subpleural lesions correlated with a higher pneumothorax rate than those farther from the pleura because shallow anchoring made needle dislodgement to the pleural cavity easy, causing air ingress.[5]

The depth of the lesion was found to be poor predictor of pneumothorax in our series. This difference was rather caused by whether the lesion was pleural or not. Accordingly in two CT-guided biopsy series, pleural lesions were associated with a very low incidence of pneumothorax; as soon as aerated lung was traversed, the risk rose considerably, but thereafter the exact depth of the lesion was not a significant factor.[6]

Lesion sizes have been detected a significant variable of pneumothorax in some series, but not in the others.[2, 5, 6] We evaluated ≤2 cm size as a poor predictor after logistic regression analysis. Number of needle passes and needle size did not increase pneumothorax rate of the various studies.[1-9] We did not find these as predictor in our series, either.

Khan et al. have hypothesized that tumor invasion of lung tissue around a spiculated lung lesion may make lung tissue less elastic and yield tissue recoiling after biopsy less effective as compared to smooth lesion margins, resulting in air ingress due to insufficient sealing of the biopsy canal after needle extraction.[5] But, their results did not support their theory. We did not find as a predictor after analyzing spiculated lesions in pneumothorax rate despite increasing in this rate of spiculated lesions.

Hemorrhage was detected in 1.5% of our patients and recovered spontaneously. During the past 2 decades, a trend toward the use of smaller needles has been driven by reports of clinically important bleeding associated with large cutting needles, not by unacceptable rates of pneumothorax.[7] So, we usually preferred smaller needles in the series. Also, it has been analyzed that →

bleeding into the needle tract may have an effect similar to the blood-patch method used for the prevention of the pneumothorax.[9] Needle track bleeding may have a positive effect on the size of pneumothorax, as well.[5] We analyzed non bleeding as a predictor of pneumothorax. Although we did not detect any significant correlation, there was no patient with pneumothorax observed in the presence of hemorrhage.

It was reported that small lesion size and long distance to the lesion increase the risk of bleeding.[5, 8] It has also been detected that there is no predictor in bleeding.[10] We could not further explore the variables for hemorrhage due to small number of patients with bleeding; this is the restriction of our study.

Manual aspiration provides successful outcome in 70-75%, so small pleural injuries may seal quickly.[7] We easily dealt with moderate (20-30%) pneumothorax by this method. Also, chest tube placement ranges from 0% to 14.9%.[6] Our chest tube drainage of 1.9% compares favorable relating to the other studies.

The diagnostic accuracy rates and yield reported in the literature vary from 65% to 96% because of differences in techniques, average nodule size, and the modality used for imaging guidance.[4, 7, 11] Our diagnostic yield of 81.5% is comparable with that of other series. Most studies limit their observations with an ultimate diagnosis of malignancy and quote sensitivities of 82-99% in these groups.[2, 6] However, the ability of the FNAB method to diagnose benign disease accurately has been found to be decreased according to many researchers.[2] It has long been accepted that the yield of fine-needle aspiration biopsy in non-malignant lesions is much less; achieving specific benign diagnoses only 39-77%.[6] Our accuracy at benign diagnosis was comparably high, which was a rate of 79.8%. This is probably due to using more often cutting needles in benign lesions than those in malignant lesions, 18% vs. 11%.

Mixed opinions exist on the effect of the nodule size on diagnostic accuracy of percutaneous lung biopsies.[11] Small lesion size[4, 8, 11] and long lesion depth[4] led to decrease in diagnostic yield in some series. Only significant variable in nondiagnostic yield was found to be lesion size smaller than 2 cm, whereas lesion depth did not affect this yield in our series.

Accordingly, more recent literature on CT-guided lung biopsies demonstrates a definite difference in the diagnostic yield and accuracy when biopsies are performed on small nodules (≤ 2 cm).[4, 11] Ohno et al. used a size criterion of ≤ 2 cm and reported a statistically significant drop in diagnostic accuracy to 77%.[4, 11] We also applied the same size criterion and found this drop from 83.7% in >2 cm lesions to 67.7% in ≤ 2 cm lesions.

In conclusion, our results clarify that percutaneous CT-guided transthoracic biopsy with either fine needle or cutting needle is an accurate method with a low complication rate in both benign and malignant lesions. The lesion depth and ≤2 cm mean size were detected to be poor predictors at pneumothorax. Pneumothorax rates were especially related to whether the lesion was pleural or not. Lesion size ≤2 cm as nominal variable was found to be only predictor regarding diagnostic accuracy, although size was not significant as continuous scale variable.

CORRESPONDING AUTHOR: Bilgin Kadri Arıbaş MD. Department of Radiology, A.Y. Ankara Oncology Training and Research Hospital, Ankara bilginaribas@hotmail.com

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