RESEARCH ARTICLE

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Computed Tomography-Guıded Tru-Cut Bıopsy in the Dıagnosıs of Lung Lesıons; Our Clınıcal Experience

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Abstract

Introduction: CT-guided tru-cut biopsy, which is less invasive and cost-effective, is an important diagnostic tool with high accuracy in lesions located peripherally in the lung. In this article, CT-guided tru-cut biopsy experiences of thoracic surgeons are shared. **Materials and Methods:** CT-guided tru-cut biopsy was performed on 200 patients with suspected lung lesions in the thoracic surgery clinic. Diagnostic rates of biopsies, complications, factors affecting the development of complications, and complication management were examined. **Results:** The diagnostic rate of the biopsies was 88%. Pneumothorax developed in 19.5% and hemothorax in 1% after the procedure. There was a significant relationship between mass dimensions and total complication rates (p=0.017). The relationship between the distance among the pleura and the mass and the development of complications was significant (p<0.001). The relationship between the number of biopsies and the development of pneumothorax was significant (p=0.011). The relationship between the size of the mass and the development of pneumothorax was significant (p=0.011). In univariate binary logistic regression analysis, a significant correlation was found between the size of the mass and the development of total complications (odds ratio (OR)=0.356 (95% CI: (0.146-0.868), (p=0.023)). **Discussion:** In the diagnosis of lung lesions, CT-guided tru-cut biopsy is an effective diagnostic tool with high diagnostic power, with its less invasiveness, and lower cost. The increase in the lung parenchyma distance passed with the biopsy needle increased the likelihood of complications most significantly. The size of the mass and the number of biopsies also had significant effects on the development of complications.

Keywords: Lung biopsy- cancer- tomography

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Introduction

Histopathological diagnosis is necessary for treatment, especially in malignant lesions of the lung. In recent years, as the number of computed tomography (CT) scans requested increased in suspicious cases, especially in patients who smoke and have a family history of cancer, the number of lung lesions detected also increased. Increased number of tomography scans during the Covid-19 pandemic also contributed to the increase in incidentally detected lung lesions. CT-guided fine needle aspiration biopsy (FNAB) and tru-cut biopsy can be performed on peripherally localized lung lesions, and in centrally located lesions, more invasive surgical interventions such as bronchoscopy, endobronchial ultrasonography-guided transbronchial needle aspiration (EBUS-TBNA), endoscopic ultrasonography (EUS) or video-assisted thoracoscopic surgery (VATS), and thoracotomy can be performed. Each process has its special place in practice with its advantages and disadvantages. CT-guided tru-cut biopsy, which is less invasive and has a low-cost, is an important diagnostic tool with high accuracy, especially in peripherally located lesions. A lung biopsy was first performed by Leyden in 1883 (Sargent et al., 1974). It was performed by Porto in 1970 by using fluoroscopy (Prolla, 1986). With the use of developing technology in the field of radiology, it is widely and more safely performed today. Pneumothorax and intra/extrapulmonary bleeding are the most common complications of this method (Westcott, 1988). There are factors such as the location of the lesion, the size of the lesion, parenchymal characteristics, and the experience of the person performing the biopsy that affects the complication and diagnostic rates. This procedure is usually performed by interventional radiologists. Radiologists may naturally refrain from the procedure in deeply located parenchimal lesions since complications are likely in partially emphysematous patients. The person who will intervene in the complications that may arise is the thoracic surgeon. Especially in risky cases, surgeons will take the initiative and contribute to a less invasive method for diagnosis of the disease. In this article, CT-guided tru-cut biopsies performed by thoracic surgeons in our clinic were examined together with diagnostic rates, complications, factors affecting

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the development of complications, and complication management.

Materials and Methods

CT-guided tru-cut biopsy was performed on 200 patients with suspected lung lesions in the thoracic surgery clinic of Kayseri City Hospital. Patient's platelet counts, PT, aPTT, and INR values were examined before the biopsy. The anticoagulant and antithrombotic drugs used by the patient were stopped a week before the intervention, and if necessary, low molecular weight heparin (LMWH), a shorter-acting drug, was initiated and terminated the day before the procedure. Before the biopsy, the patients were informed about the procedure and their written consent was obtained. Patients with a lesion diameter less than 1 cm, suspected vascular origin, pure cystic structure, diffuse bullous lung structure, unable to comply with the given instructions and position, and who underwent pneumonectomy were not included in the procedure. The distance of the lesion to the pleura and mild-moderate emphysematous lung structure was not considered an obstacle to biopsy.

The patients were prepared either in the supine or prone position to reach the lesion. The lateral position was not preferred since it was difficult to stabilize the patient. The patients were trained to remain as still as possible and not to take deep breaths. The lesion area was scanned by using 1-5 mm CT slices. The indicator light of the CT device was targeted at the axial section on the targeted tissue, and the needle entry site was marked by measuring the target tissue's distance from the midline or lateral. While determining this place, the perpendicular entrance to the lesion and the shortest path to be followed in the parenchyma were preferred. The needle angle was roughly calculated in cases where vertical entry into the skin could not be made. Depending on the distance from the skin to the lesion, a 10 cm or 15 cm semi-automatic biopsy needle was preferred. After local area cleaning, 3 ml of lidocaine was injected into the cutaneus and subcutaneous tissue. In the axial section, the distance from the skin to the lesion was measured. The 18 gauge semi-automatic guillotine biopsy needle was advanced at the appropriate angle by the measured distance. While the needle was in, a new image was taken with 1 mm sections and a biopsy was performed when the appropriate position was achieved. If the biopsy material was thought to be macroscopically inadequate, a second biopsy was performed. Complications were evaluated by tomography after biopsy.

Statistical evaluation

The Shapiro Wilk Test and histogram and Q-Q plot graphs were used to examine the normality of continuous variables. Levene Test Statistics value was used to evaluate the homogeneity of variance. In comparisons between groups regarding total complication and pneumothorax variables, Mann-Whitney U Test was applied for continuous variables, while Pearson chi-square analysis was used to determine the relationships between categorical variables.

Univariate binary logistic regression analysis was applied to determine the factors affecting the total complication and pneumothorax status. The backward elimination method was applied in multivariate binary logistic regression (model: Bacward-wald). Odds ratios and 95% confidence intervals were calculated. Analysis of the data was performed by using TURCOSA (Turcosa Analytical Analysis Ltd. Şti. Kayseri/Turkey). A p value of <0.05 was accepted as significant.

Results

CT-guided tru-cut biopsy was performed on 200 patients with suspicious lung lesions. No diagnosis could be made in 24 (12%) patients, either benign or malignant. These biopsies were reported as normal lung tissue, suspected tumor, or pleura. Benign diagnoses such as pneumonia, tuberculosis, fibrosis, and inflammatory pseudotumor were made in 29 (14.5%) patients. The biopsy specimed was diagnosed as a malignant tumor in 147 (73.5%) patients.

Complıcatıons

1-Pneumothorax

Postoperative pneumothorax developed in 39 (19.5%) of 200 patients who underwent CT-guided transthoracic biopsy. Tube thoracostomy was performed in 22 (11%) patients who had a pneumothorax ratio of 10% or more and in patients who had a pneumothorax rate of less than 10% but developed dyspnea after biopsy. Patients with pneumothorax of less than 10% and no dyspnea were followed up with medical treatment. Before tube thoracostomy was applied, 33 patients were followed up with oxygen support. Tube thoracostomy was performed due to the increase in pneumothorax rate or the development of dyspnea during the follow-up period. Chest tube follow-up period of the patients due to pneumothorax lasted between 2-8 days (mean:3.6).

2-Hemorrhage

Hemothorax developed in 2 (1%) patients after biopsy. One patient was treated with a pleurocan insertion and hospitalized for 3 days for follow-up. The other patient was hospitalized for 1 day without any intervention. Hemopneumothorax developed in 2 patients. A tube thoracostomy was performed. One patient was hospitalized for two days and the other for eleven days. Intrapulmonary hemorrhage developed in 4 (2%) patients. Two (1%) patients who had hemorrhage along the biopsy needle line were discharged on the same day. One of the 2 patients who developed intraalveolar hemorrhage in a larger area around the lesion was followed up with daily chest X-rays for one day and the other for four days and were discharged without the need for intervention (Table 1).

Complications developed in 47 of the 200 people who were included in the study. Pneumothorax was observed in 39 of these patients. The mean age of people with pneumothorax was 30, while the mean age of people without pneumothorax was 42.

The relationship between mass dimensions and total complication rates was statistically significant (p=0.017). In patients without complications, those with a mass of

Table 1. Effect of Variables on Complications

	Total complication Yes n (%)	Total complication P-value	Pneumothorax Yes n (%)	Pneumothorax P-value
Categorıcal Varıables				
Gender				
Male	36 (76.6)	0.44	31 (19.3)	0.859
Female	11 (23.4)		8 (20.5)	
Age				
Under 60 years	11 (23.4)	0.259	10 (25.6)	0.508
60 years and over	36 (76.6)		29 (74.4)	
Dimensions				
2 cm and below	12 (25.5)	0.017	9 (23.1)	0.053
2-4 cm	21 (44.7)		18 (46.2)	
4 cm and over	14 (29.8)		12 (30.8)	
Position				
Supine	29 (61.7)	0.847	25 (64.1)	0.608
Prone	18 (38.3)		14 (35.9)	
Needle length				
10 cm	39 (83)	0.284	33 (84.6)	0.544
15 cm	8 (17)		6 (15.4)	
Between pleura and mass				
0 cm	6 (12.8)	<0.001	1 (2.6)	<0.001
2 cm and below	25 (53.2)		24 (61.5)	
2-4 cm	16 (34)		14 (35.9)	
Number of biopsies				
1	26 (55.3)	0.062	24 (61.5)	0.011
2	21 (44.7)		15 (38.5)	
Diagnosis				
Malign	35 (74.5)	0.637	28 (71.8)	0.764
Benign	8 (17)		7 (17.9)	
No Diagnosis/Suspected	4 (8.5)		4 (10.3	
Intervention				
Oxygen	15 (7,5)		15 (7,5)	
Chest tube	25 (12,5)		22 (11)	
Contınuous Varıables				
Age	65 (61-71)	0.883	30 (22-42)	0.778
Size	30 (20-42)	0.003	15 (9-25)	0.011
Pleural distance	15 (5-25)	<0.001	64 (59-71)	<0.001

Values are given as n(%), mean±SD, or median (1st-3rd quartile values).

4 cm and above were the most common (53.2%); while among the patients who developed complications, the group with the highest complication had 2-4 cm masses in size.

The mean of the pleura-mass distance variable was shorter in patients without complications (5mm) than in patients who developed complications (15mm). The relationship between the pleura-mass distance and the development of complications was significant (p<0.001). While pleural-based masses had the lowest complication rate, the group with the highest complication rate was those with a pleura -mass distance of 2 cm or higher (53.2%). The relationship between the pleura-mass distance and the development of pneumothorax was significant (p<0.001).

The relationship between the number of biopsies and the development of pneumothorax was significant (p=0.011). Those who did not develop pneumothorax and had the highest rate of biopsy (60.9%) underwent two biopsies, while most of the patients who developed pneumothorax had biopsy only once (61.5%).

The difference between the complication groups regarding the mass size was significant (p=0.003). The mean of the size variable was greater in the patients who had no complications(44mm) compared to patients with complications (30mm). The difference between

Table 2. Univariate and Multivariate Binary Logistic Regression Analysis of Adverse Events and Complications

	Total Complication				Pneumothorax			
	Univariate		Multivariate		Univariate		Multivariate	
	OR (%95 CI)	P-value	OR (%95 CI)	P-value	OR (%95 CI)	P-value	OR (%95 CI)	P-value
Categorical Variables								
Gender								
Male	1,000	0.441			1,000	0.859		
Female	1.364 (0.619-3.005)		-		1.082 (0.453-2.584)		-	
Age								
Under 60 years	1,000	0.261			1,000	0.509		
60 years and over	1.542 (0.724–3.283)		-		1.306 (0.591-2.885)		-	
Dimensions								
2 cm and below	1,000	0.020	1,000	0.096	1,000	0.060		
2-4 cm	0.951 (0.402-2.248)	0.909	0.865 (0.348-2.150)	0.755	1.143 (0.453-2.882)	0.777	-	
4 cm and over	0.356 (0.146-0.868)	0.023	0.409 (0.161-1.039)	0.060	0.444 (0.169-1.166)	0.099	-	
Position								
Supine	1,000	0.847			1,000	0.608		
Prone	0.936 (0.478-1.832)		-		0.827 (0.400-1.710)		-	
Needle length								
10 cm	1,000	0.287			1,000	0.545		
15 cm	1.641 (0.659-4.088)		-		1.359 (0.503-3.668)		-	
Between pleura and mass								
0 cm (pleural-based)	1,000	0.001	1,000	<0.001	1,000	0.005		
2 cm and below	4.931 (1.897-12.813)	0.002	4.606 (1.757-12.073)	<0.001	29.902 (3.933-227.345)	0.001	-	
2-4 cm	8.606 (3.002-24.670)	<0.001	7.402 (2.536-21.610)	0.170	44.333 (5.538-354.869)	<0.001	-	
Number of biopsies								
1	1,000	0.064			1,000	0.013		
2	0.536 (0.277-1.036)		-		0.402 (0.196-0.824)		-	
Diagnosis								
Malign	1,000	0.641			1,000	0.765		
Benign	1.219 (0.496-2.994)	0.666	-		1.352 (0.526-3.479)	0.531	-	
No Diagnosis	0.640 (0.205-1.998)	0.442	-		0.850 (0.269-2.684)	0.782	-	
Continuous Variables								
Age	0.996 (0.969-1.025)	0.807	-		1.001 (0.971-1.032)	0.949	-	
Size	0.981 (0.965-0.998)	0.029	-		0.976 (0.957-0.995)	0.013	0.979 (0.960-0.999)	0.041
P.distance	1.040 (1.016-1.066)	0.001	-		1.048 (1.022-1.075)	<0.001	1.044 (1.017-1.072)	0.001

OR, Odds Ratio; CI, Confidence Intervals

the pneumothorax groups in terms of size variable was significant (p=0.011) (Table 2).

As a result of univariate binary logistic regression analysis, the size and distance between pleura and mass variables were significant for the dependent variable of total complications. According to odds ratios, those who had 4 cm and above in the size variable were 2.80 times less likely to develop total complications than those with 2 cm and less (odds ratio (OR)=0.356 (95% CI: (0.146-0.868), (p=0.023)). Patients with a pleura-mass distance of 2 cm or less were 4.931 times more likely to develop complications than those with 0 cm (OR=4.931 (95% CI: 1.897-12.813), (p=0.001)). The probability of developing a total complication was 8.606 times higher in patients with a pleura-mass distance of 2-4 cm compared to those with a distance of 0 cm (OR=8.606 (3.002-24.670), (p<0.001)). As the size variable value increases by 1 unit, the probability of developing total complications decreases 1.020 times (OR=0.981 (0.965-0.998), (p=0.029)). As the pleura-mass distance variable value increases by 1 unit, the probability of developing total complications increases 1.040 times (OR=1.040 (1.016-1.066), (p=0.001)). Distance between pleura and mass was significant in multivariate binary logistic regression analysis for the dependent variable of total complications. When the effects of other independent variables were excluded, the effect of the distance between the pleura-mass variable less than 2 cm and the effect on the total complication variable compared to those with 0 cm decreased from 4.931 to 4.606 (OR=4.606 (1.757-12.073), (p<0.002)). When the effects of other independent variables were removed, the effect of the distance between the pleura-mass variable of 2-4 cm and the effect of the total complication variable compared to those with 0 cm decreased from 8.606 to 7.402 (OR=7.402 (2.536-21.610), (p<0.001)).

Univariate binary logistic regression analysis results for the dependent variable of pneumothorax, the distance between pleura and mass, the number of biopsies, and size variables were statistically significant. According to odds ratios, in the pleura-mass distance variable, those with 2 cm or less were 29.902 times more likely to develop pneumothorax than those with 0 cm (OR=29.902 (3.933-227.345), (p=0.001)). In the pleura-mass distance variable, the probability of developing pneumothorax was 44,333 times more in those with 2-4 cm compared to those with 0 cm (OR=44.333 (5.538-354.869), (p<0.001)). As the size variable value increases by 1 unit, the probability of developing pneumothorax decreases 1,024 times (OR=0.976 (0.957-0.995), (p=0.013)). As the pleura-mass distance variable value increases by 1 unit, the probability of developing pneumothorax increases 1.048 times (OR=1.048 (1.022-1.075), (p<0.001)). In the multivariate binary logistic regression analysis for the pneumothorax variable, the distance between the pleura and the mass and the numerical variables of size were significant. When the effects of other independent variables were removed, the effect of the distance between the pleura-mass variable on the pneumothorax variable decreased from 1.048 to 1.044 (OR=1.044 (1.017-1.072), (p=0.001)). When the effects of other independent variables were excluded, the effect of the size variable on the pneumothorax variable increased from 0.976 to 0.979 (OR=0.979 (0.960-0.999), (p=0.041)).

For the multivariate binary logistic regression model created for the total complication variable, the Hosmer and Lemeshow Test result was found chi-square=5.266, p=0.510. According to this result, it can be said that the multivariate binary logistic regression model is a suitable model for estimating the total complication variable. Chi-square=26.111 and p<0.001 was found for the Omnibus Test of model coefficients. According to this result, it can be said that the multivariate binary logistic regression model created is statistically significantly better. The Nagelkerke R2 value was found to be 0.184. The model created according to this value is significant. It means that the independent variables in the multivariate binary logistic regression model explained 18.4% of the total complication variable.

For the multivariate binary logistic regression model created for the pneumothorax variable, the Hosmer and Lemeshow Test result was found chi-square=12.835, p=0.118. According to this result, it can be said that the multivariate binary logistic regression model is a suitable model for estimating the pneumothorax variable. Chi-square=17.865 and p<0.001 was found for the Omnibus Test of model coefficients. According to this result, it can be said that the multivariate binary logistic regression model created is statistically significantly better. The Nagelkerke R2 value was found to be 0.136. The model created according to this value was moderately significant. It means that the independent variables in the multivariate binary logistic regression model explained 13.6% of the pneumothorax variable.

Discussion

With the increase CT scan use, the number of detected lung lesions increased. The solid and semisolid suspicious lesions have a high risk of malignancy, especially in people who smoke and/or have a family history of lung cancer. For patients aged 55-75 years, the probability of malignancy increases more than 1.2 times every 10 years (Gould et al., 2007). Histopathological diagnosis is essential for the treatment of lung cancers. CT-guided percutaneous transthoracic needle biopsy can diagnose lung lesions and the success rate increases with the advancement of technology and experience (Haaga and Alfidi, 1976; Fielding et al., 2012). It is also an advantage in that it is less invasive and less costly compared to other diagnostic procedures.

The average size of the lung lesion of 200 patients in this study was 42.1 mm. In 176 (88%) patients, a benign or malignant diagnosis was achieved as a result of the biopsy. In 24 (12%) patients, a diagnosis could not be made or a suspicious diagnosis was made due to insufficient biopsy material or inability to obtain a biopsy from an appropriate site. Re-biopsy was performed in 14 (7%) patients who were followed up and agreed to repeat the biopsy. It was determined that the complication rates were high and achieving the diagnosis was less successful in patients who cannot stand still enough during the biopsy. To overcome this compliance problem, it is necessary to provide more detailed information to the patients about the procedure and a suitable position should be accomplished where the patient will not feel the need to move during the procedure. Therefore, the procedure was not preferred to be performed in the lateral position.

In a meta-analysis in 2017, the incidence of pneumothorax was reported as 8-64% and the incidence of hemorrhage was 26-33% (Heerink et al, 2017). The rate of pneumothorax development in this study was 19.5%. Of these, 11% required surgical intervention, and 8.5% were followed up with no-intervention under oxygen treatment. Follow-up periods were 2-8 days for those who had a surgical intervention and 1-2 days for those who were followed-up under oxygen treatment. In this study, the number of patients who developed hemothorax was 2 (1%), the number of patients who developed intraalveolar hemorrhage was 4 (2%), and the number of patients who developed hemopneumothorax was 2 (1%). No mortal complication was observed.

In many studies, it was reported that complication rates increase as the distance between the pleura and the mass increases (Capalbo et al., 2014; Sachdeva et al., 2016; Sangha et al., 2016; Xu et al., 2018). In this study, it was seen that as the distance between the pleura and the mass increases, the probability of developing complications increases, and this situation is statistically significant.

In our study, a statistically significant result was obtained between the size of the mass and the development of complications. While the least complication was observed in the group with 4 cm and above, the highest complication rate was observed in the group who had a mass size between 2-4 cm. In a study conducted in the USA in 2016, it was reported that complication rates decreased with the increase in mass size, but this was not statistically significant (Sachdeva et al., 2016). In a study conducted in Canada in 2016, it was found that the complication rates decreased with the increase in mass size (Sangha et al., 2016). In the core biopsy study of lesions smaller than 2 cm in China in 2018, the nodule group below and above 1 cm was examined. It was reported that hemorrhagic complications were seen significantly less in the large-size group, but no significant difference was observed in the development of pneumothorax (Xu et al., 2018). In a study published in the USA in 2015, it was reported that complication rates were most common in 2-4 cm-sized masses, as in our study (Schulze et al., 2015). In a study conducted in Italy in 2014, it was observed that pneumothorax and pneumothorax + hemorrhagic complication rates decreased with the increase in mass size, but only hemorrhagic complication rates increased (Capalbo et al., 2014).

In our study, when the patient groups who had a lesion biopsied once and twice in the same session were compared, it was found that the development of pneumothorax was significantly less common in those who had biopsies twice. Although the total complication rates were not statistically significant, it was found that it was less common in those who had undergone 2 biopsies. In a study published in China in 2018, it was reported that complication rates were higher in the group that underwent 2 biopsies (Xu et al., 2018). In a study conducted in Italy in 2014, it was reported that complication rates were lower in patients who underwent one biopsy compared to those who underwent multiple biopsies (Capalbo et al., 2014).

In conclusion, CT-guided tru-cut biopsy is an effective diagnostic tool with high diagnostic power, relatively less invasiveness, and lower cost in the diagnosis of peripherally located tumor suspicious lesions in the lung, which are increasingly detected today. It is the increase in the lung parenchyma distance passed with the biopsy needle, that is, the distance between the pleura and the mass, which increases the likelihood of complications most significantly. The size of the mass and the number of biopsies also have significant effects on the development of complications. Surgeons are involved in the intervention of complications. It is thought that surgeons will be more useful in diagnosing with a minimally invasive method, especially in patients with a high risk of complications, by taking this risk.

Author Contribution Statement

All authors contributed equally in this study.

Acknowledgements

Ethical Declaration

The study was approved by the Ethics Committee of the Faculty of Medicine, Erciyes University, study code no: 2019/06.

Data Availability

The data that support the findings of this study are available from the corresponding author. The data are not publicly available due to privacy or ethical restrictions

Research objective

This study is not a part of an approved student thesis or a scientific body.

Conflict of Interest

The authors declare that there is no conflict of interest.

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