Research Article / Araştırma Makalesi

Efficiency of Hydrogel Plugging System in Non-Pleural Lung Masses

Plevral Tabanlı Olmayan Akciğer Kitlelerinde Hidrojel Tıkaç Sistemi Etkinliği

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Abstract

Background: This study aims to evaluate the complications of non-pleural-based lung biopsies performed under Computed Tomography (CT) guidance and the ability of the hydrogel plugging system to prevent them.
Materials and Methods: Biopsy was performed in 46 cases with non-pleural-based lung mass with a coaxial system, accompanied by CT. A hydrogel plug was immediately inserted into the tissue without removing the coaxial needle. At the end of the procedure and 2 hours later, a 5 cm area in the biopsy area was controlled by CT and 24 hours later by chest X-ray. Pneumothoraxes detected even in a single control were accepted as positive results. The data obtained were evaluated regarding the literature based on the parameters like mass size, pleural distance, emphysema, age, smoking history, and passing fissure.
Results: Pneumothorax was the most encountered complication observed in 13 cases (26.5%) in the study. Thorax tube was placed in one of these cases (2.04 %). The highest rate of pneumothorax development was detected in lesions over 4 cm (33.3%) distance. In cases where a fissure was passed, pneumothorax occurred in five (71.4%) patients. When patients with and without pneumothorax were compared in terms of age, a statistically significant difference was found (p = 0.032).
Conclusions: The results show that the hydrogel plug application is a successful and safe method. When pneumothorax cases were analyzed, the development of massive pneumothorax requiring tube drainage in only one patient and the acceptable percentage of pneumothorax can be considered the success of the method.

Key Words: Pneumothorax, Lung, Mass, Biopsy, Hydrogel

Öz

Amaç: Bu çalışma Bilgisayarlı Tomografi (BT) kılavuzluğunda yapılan plevral tabanlı olmayan akciğer biyopsilerinde gerçekleşen komplikasyonları ve hidrojel tıkama sisteminin bunları önleme yeteneğini değerlendirmek için yapılmıştır.
Materyal ve Metod: Plevral tabanlı olmayan akciğer kitle biyopsisi planlanan 46 vakaya BT eşliğinde koaksiyel sistemle biyopsi yapıldı. Takiben koaksiyel iğne çıkarılmadan hemen hidrojel tıkaç dokuya yerleştirildi. İşlem bitiminde ve 2 saat sonrasında biyopsi bölgesinde 5 cm'lik bir sahaya BT ile, 24 saat sonra akciğer grafisiyle kontrol edildi. Tek bir kontrolde bile saptanan pnömotorakslar pozitif sonuç olarak kabul edildi. Elde edilen veriler kitle boyutu, plevral mesafe, amfizem varlığı, yaş, sigara öyküsü, fissür geçme parametreleriyle literatür verileriyle karşılaştırılarak değerlendirildi.
Bulgular: Çalışmada en çok saptanan komplikasyon 13 olgu (%26,5) ile pnömotoraks oldu. Bu olgulardan birine (%2,04) toraks tüpü yerleştirildi. En yüksek pnömotoraks gelişme oranı 4 cm üstü (%33,3) lezyonlarda saptandı. Fissür geçilen olgularda beş vakada (%71,4) pnömotoraks gerçekleşti. Pnömotoraks gelişen ve gelişmeyen hastalar yaş değişkeni açısından karşılaştırıldığında istatistiksel olarak anlamlı farklılık bulundu (p=0.032).
Sonuç: Sonuçlara göre hidrojel tıkaç uygulamasının başarılı ve güvenli bir yöntem olduğunu göstermektedir. Pnömotoraks olguları analiz edildiğinde sadece bir olguda tüp drenajı gerektiren düzeyde masif pnömotoraks gelişmesi ve pnömotoraks yüzdesinin kabul edilebilir düzeyde olması yöntemin başarısı olarak kabul edilebilir.

Anahtar Kelimeler: Pnömotoraks, Akciğer, Kitle, Biyopsi, Hidrojel

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Introduction

Although mass lesions located in the thorax are common, it is difficult to reach a diagnosis only with clinical and radiological examinations. Therefore, early and accurate diagnosis of mass lesions in the thorax, planning medical and surgical treatment, and more importantly, avoiding unnecessary thoracotomies constitute the main requirement of transthoracic needle biopsies. Percutaneous lung biopsies are a well-defined method for sampling pathological tissues in the pulmonary tissue (1, 2). Being less invasive, having a low risk, being cheaper, and having high diagnostic value is why these interventional procedures are preferred more than surgical techniques. Computed tomography (CT) has been used for more than twenty years as a standard imaging technique and as a guide in percutaneous interventions (3).

Biopsies are grouped as aspiration and piece rupture according to the material taken. When aspiration biopsies are performed using fine calibrated needles, it is called fine-needle aspiration biopsy (FNAB). Fragment detachment biopsies are known as tru-cut or core biopsies (4).

Using computed tomography for biopsy procedure; provides valuable information on the feasibility of the pre-procedure, predicting possible risks and complications, determining the appropriate insertion site, choosing the area to be sampled, following the needle during the procedure, and showing post-procedure complications (4).

Pneumothorax, the most common complication of the procedure, is reported at a rate of 8% -61% in different series (5-8). In most cases, pleural air accumulation regresses without any intervention, and a chest tube must be inserted in a small number of the patient. Our aim in this study; investigate the effectiveness of Bio-Seal (Angiotech Pharmaceuticals, Inc., Vancouver, Canada) hydrogel plug biopsy line occlusive system, which the body can absorb within days (9) and used to prevent pneumothorax in coaxial biopsies performed with the transthoracic percutaneous approach in non-pleural thoracic masses and evaluation of factors affecting the development of pneumothorax.

Materials and Methods

In this study, we conducted a cross-sectional study with 46 patients. Forty-six patients with lung masses without pleural contact who were sent to the radiology clinic with a biopsy request from various clinics of Uludağ University Medical Faculty were performed transthoracic biopsy with a tract-closing hydrogel plug system, accompanied by computer tomography. All biopsies were performed under a computer tomography device (Siemens Somatom Plus-4, spiral (1998), Somatom Emotion, Siemens, (2005), Erlanger, Germany). In the procedure, 20G semi-automatic cutting biopsy needles were sent coaxially through a 19G guide needle (a Greene 22-gauge needle in a 19-gauge introducer needle (Cook Europe, Bjaeverskov, Denmark)) were used.

The biopsy method and possible complications were explained, and patients were informed about the treatment methods for the complications Informed consent was obtained from all the patients. This study was carried out with the approval of the Uludağ University Research Ethics Committee dated 11 January 2011 and numbered 2011-2 / 6.

Factors thought to cause pneumothorax was evaluated by classifying lesion size, pleural lesion distance, age, smoking history, presence of emphysema, and fissure passage. The presence of emphysema was assessed visually. The length of the lung parenchyma the needle passed during the procedure was evaluated as the pleural lesion distance. Accordingly, the lesions were divided into three groups. Those passing through the parenchyma were grouped as 0-2, 2-4, and 4-6 cm. The presence of a fissure in the needle trace was noted. The coaxial needle thickness used for biopsy was 19G Cutting Needle Biopsy (ICP) needle 20G. Semi-automatic gun needles were used in KIB. The person performing the biopsy was the same radiologist in all cases. After determining the appropriate insertion point on CT scans, the anesthesia area was adjusted by measuring the distance from the skin to the ribs. Approximately 3-5 cc of local anesthetic substance (Citanest® 2%, AstraZeneca) was injected into this area with a dental needle tip injector. After the 19G coaxial needle reached the lesion edge or inside, the mandrel was removed. The inner needle with a semi-automatic gun system with the cutting area on the side was inserted into the outer cannula, and an incomplete biopsy was performed.

The lung filling material we use is a Bio-Seal Biopsy Line cover, dried polyethylene glycol hydrogel. The hydrogel has a solid cylindrical structure (2.5 cm in length and 0.1 cm in diameter). When the hydrogel meets wet tissue, the hydrogel that absorbs the liquid expands and fills the line opened by the coaxial needle with its volume and is airtight. The biopsy line closure system consists of an adapter with a dry hydrogel plug and a loading mechanism. The loading mechanism is a thin metal pusher with depth adjustment designed to send the hydrogel plug to the desired depth. It is pulled into the coaxial needle with its style until 1 cm of the visceral pleural surface remains. In this way, it is ensured that the hydrogel plug is fully spread to the pleural surface and the superficial part of the biopsy line and that possible air leakage does not reach the pleural surface. The sterile set is opened, and the loader system and plug are removed. The coaxial adapter is assembled after being pulled, introduced, and dropping a small amount of physiological saline on it, ensuring the environment is moistened for the hydrogel plug (Figure 1). Following these procedures, the distance between the skin and the pleura is entered and locked into the system using the wheel on the loader. The loader system is placed behind the coaxial adapter, ensuring the introducer does not enter. After the system is in complete contact with the skin, the adapter attached to the coaxial system is pulled out along the line of the loader system without retracting the system (Figure 2).

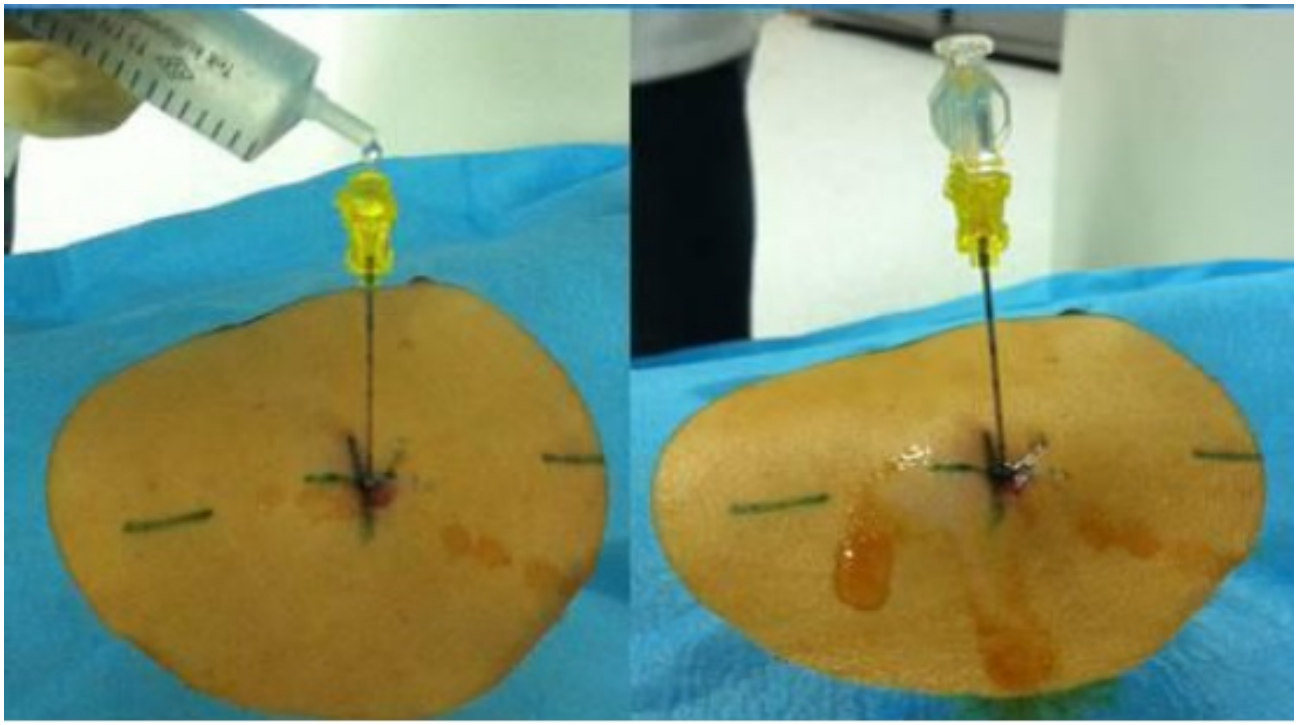

Figure 1. Opening the occlusive system and attaching the gag adapter by dripping coaxial saline

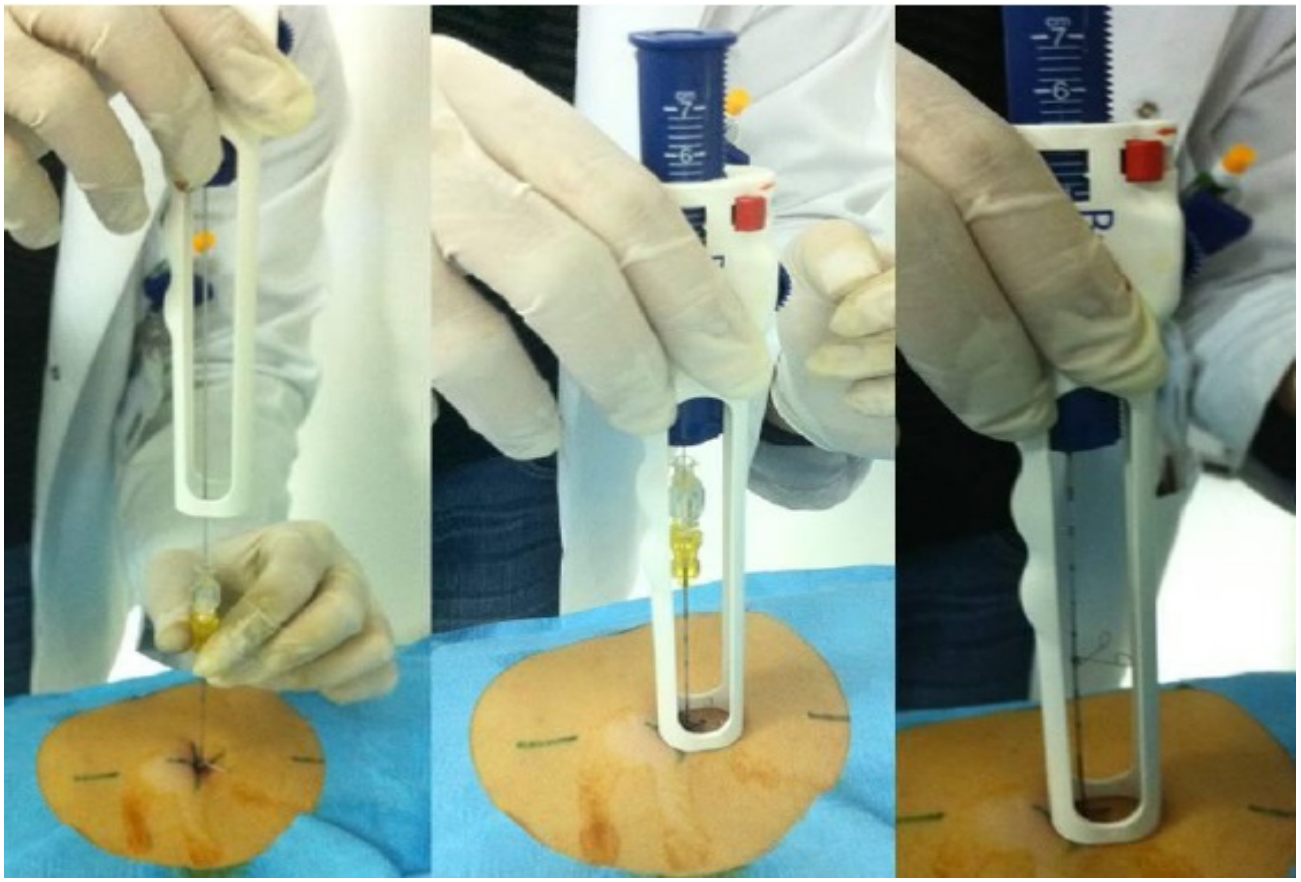

Figure 2. Insertion of the hydrogel plug into the coaxial system with the loader

After the area where the coaxial adapter combination will go posteriorly, the system is pulled together with the installer.

Pneumothorax and parenchymal hemorrhage were controlled by taking axial sections from the biopsy level without removing the patients. The patients were sent to the patient bed on a stretcher, with the needle entry at the bottom. After the biopsy, pneumothorax was controlled with 5 cm thick CT sections at the 2nd hour and chest radiography at the 24th hour. After the second hour of control, stable patients who did not have pneumothorax were sent to their ward with recommendations, or day-hospitalized patients were discharged. The patients were asked to apply to our hospital or radiology unit in case of any complaints in the week after the last radiographs were seen. Patients with pneumothorax of 4 cm or less were sent to their ward if they did not progress at the 6th hour. One day later, the patient was discharged if there was no progression in the pneumothorax and asymptomatic. A chest tube was inserted after consultation with symptomatic patients with pneumothorax or progression during follow-up after thoracic surgery.

In the statistical analysis, whether the data showed the Shapiro-Wilk test examined normal distribution. Descriptive statistics are expressed as the mean and standard deviation for quantitative data and as frequency and percentage for qualitative data. The t-test was used to compare two groups for data with normal distribution. Pearson Chi-square test, Fisher's exact chi-square test, and Fisher-Freeman-Halton test were used to analyze categorical data. Binary logistic regression analysis was performed to determine factors affecting the development of pneumothorax. The level of significance was defined as $\alpha = 0.05$. Statistical data analysis was performed in the IBM SPSS 20.0 (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.) statistical program.

Results

This study included 38 males and eight females, 46 cases. In all these cases, a semi-automatic cutting biopsy needle with a coaxial system was used in the transthoracic biopsy procedure. While pathological diagnosis could be obtained from samples belonging to 43 cases in the first procedure (93.5%), the histopathological diagnosis could be made in 3 patients (6.5%) because of the process performed for the second time. The total number of interventions was 49, including 3 cases whose procedures were repeated. The patients' mean age was 60.33 ± 9.26 (Table 1).

Pneumothorax was the most common complication. Tube drainage was applied in one of these cases (2.04%). Pneumothorax developed in 13 of 49 interventions (26.5%). Of the masses, 6 (46.2%) were 3 cm below, 5 (38.5%) were between 3-6 cm, and 2 (15.4%) were over 6 cm in size. The parenchymal distances crossed to reach the masses of cases with pneumothorax were found to be below 2 cm in 8 (61.5%), between 2-4 cm in 2 (15.4%), and above 4 cm in 3 (23.1%).

Table 1. Descriptive statistics for demographic variables

Variables	n=46
Age (Mean±standard deviation)	60.33±9.26
Gender	
Female(n,%)	8(%17.4)
Male (n,%)	38(%82.6)
Complication(s)*	
Pneumothorax (n,%)	13 (%26.5)
Parenchymal hemorrhage (n,%)	6 (%12.2)
Hemoptysis (n,%)	1 (%2)

**The total number of patients was 46. The total number of interventions was 49.*

Pneumothorax developed in five of seven interventions who underwent transthoracic biopsy and passed fissure, while pneumothorax was found in five of 20 cases with emphysema during the procedure. A significant relationship was found between passing fissure and pneumothorax (p = 0.010) (Table 2). Pneumothorax developed in 10 of 34 patients with a smoking history. In our study, no statistically significant difference was found between smoking history and the development of pneumothorax (p=1.000). A statistically significant difference was found when the patients with and without pneumothorax were compared in terms of the age variable (p = 0.032). The mean age of patients with pneumothorax (56.00±9.33) was lower than the patients without pneumothorax (61.89±8.85).

Table 2. Comparison of variables according to the presence of pneumothorax

		Pneumothorax		p
		- (n=36)	**+ (n=13)**	
Fissure pass	-	34	8	**0.010**
	+	2	5	
Parenchyma distance passed	<2	18	8	0.565
	2-4	12	2	
	>4	6	3	
Emphysema	-	21	8	0.840
	+	15	5	

The total number of interventions was 49.

For multivariate analysis, factors affecting the development of pneumothorax were examined by binary logistic regression analysis. The model included age, gender, smoking, fissure pass, parenchyma distance, and emphysema variables (Table 3). Age, smoking status, parenchyma distance passed, and emphysema variables were not statistically significant. But gender and fissure pass was found to be statistically significant. Females were 8.136 times more likely to have pneumothorax than males. Also, patients having fissure passes were 12.8 times more likely to have pneumothorax than others.

Table 3. Binary logistic regression result for pneumothorax

	p	OR	95% Confidence Interval OR	
			Lower	Upper
Age	0.155	0.941	0.865	1.023
Gender (female)	**0.046**	**8.136**	**1.041**	**63.574**
Smoker	0.259	3.322	0.412	26.770
Fissure pass (+)	**0.017**	**12.800**	**1.569**	**104.454**
Emphysema (+)	0.878	1.150	0.194	6.829
Parenchyma distance passed(2-4 vs. <2)	0.721	0.680	0.082	5.637
Parenchyma distance passed(>4 vs. <2)	0.737	1.445	0.168	12.401

OR: Odds ratio

Table 4. Line closer studies in the literature (21)

Author(s)	Line Closer	n	Pneumothorax (%)	Chest Tube (%)	P
Petsas et al.	fibrin glue	26	19.2	3.8	<0.05
Lang et al.	autologous blood	47	9	0	<0.05
Billich et al.	saline	70	8	1.4	<0.05
Zaetta et al.	hydrogel	170	18	4	<0.05
Malone et al.	autologous blood	123	26	9	<0.05
Tran et al.	gelatine	145	25.4	6.9	<0.05
Li et al.	saline	161	6.2	0.6	<0.05
Clayton et al.	autologous blood	245	28	4	<0.05
Graffy et al.	autologous blood	482	30	3.7	<0.05
Ahrar et al.	hydrogel	317	20.8	8.2	<0.05
Kılıç et al.	hydrogel	49	26.5	2	<0.05

Discussion

This study evaluated the results of 49 percutaneous transthoracic cutting needle biopsies performed using a CT-guided hydrogel plug system. Complications were pneumothorax in 13 patients, parenchymal hemorrhage not requiring intervention in six patients, and hemoptysis in one patient. In the follow-up of one of the patients who developed pneumothorax, the amount and symptoms of pneumothorax were observed, and a chest tube was required to treat pneumothorax. Apart from these complications, no complications were detected, and there was no procedural mortality. In our study, the rate of pneumothorax was 26.5%. This finding was consistent with the biopsy literature (10-15) without line closure systems, while it was relatively high compared to the study literature (9, 16-20).

The concept of biopsy line closure has been tested in transthoracic biopsies for the past 30 years. Besides line closure with the hydrogel plug we examined in our study, autologous blood clots, fibrin glue, and collagen foam plug are other methods that have been tried (16-20). In the 19G needle-made series published by Lang et al. (16), patients with and without autologous clots were compared, and pneumothorax was observed at 9% in the group in which blood clot was used in the deeply located lesion. At the same time, this rate was found to be 47% in the control group. In the study of Petsas et al. (19), pneumothorax was found to be 40.6% in the control group in the transthoracic biopsies performed with 19 and 22G needles in 58 patients with COPD, while it was found to be 19.2% in the patient group applied fibrin glue. In the study of Engeler et al. (20), biopsy line closure with collagen foam was involved, and pneumothorax was found to be 28% in the control group and 8% in the collagen foam group.

The hydrogel plug we used in our study expands by absorbing liquid in the area where it is placed and closes the line with mechanical resistance. The advantage of this method over autologous blood clot plug is that no additional intervention and preparation is made for the patient before the procedure. Another technique, collagen foam, needs to be processed by the user to bring it into a suitable particulate form before application. Apart from this, this spongy material cannot create an apparent mechanical resistance where it is placed.

In a randomized study on the hydrogel plug line closure system, Zaetta et al. (9) reported that 31% of pneumothorax developed in the control group and 18% in the hydrogel plug group. We think that the reason for the lower pneumothorax rate of 18% in the hydrogel plug group in the study of Zaetta et al. compared to the percentage of pneumothorax at the level of 26.5% we obtained in our series was the inclusion of lung masses with a pleural based in the study of Zaetta et al.(9). Although a low pneumothorax of 9% was observed in the study of Lang et al. (16), in which an autologous blood clot was used, there are also publications in the literature stating that no significant decrease was found in pneumothorax rates in studies conducted with this method. Among these studies, in the study of Topal and Berkman (6), 33.9% pneumothorax was found in the group in which autologous blood clot was used, and this rate did not show a significant difference from the control group. In the study by Petsas et al. (19) of 58 cases with chronic obstructive pulmonary disease in 1995 with fibrin glue, the rate of pneumothorax development was found to be 19.2%, which was revealed that the method could be applied successfully. In the study conducted by Engeler et al. (20) with collagen foam, there was a significant decrease in

the pneumothorax rate compared to the control group. Still, it was also stated that no significant differences were observed in other studies with this material.

Pneumothorax progressed in only one (7.6%) of 13 patients who developed pneumothorax among 49 biopsy procedures, and a chest tube was required. The risk factor, in this case, was smoking history. In 12 patients that developed pneumothorax were sent to their homes when the pneumothorax did not progress in the chest, radiographs were taken at the 2nd, 6th, and 24th hours. Because, although very rarely, the development of pneumothorax has been reported 24-48 hours after the procedure (16). When the rates of progression and chest tube insertion in cases with pneumothorax were examined in the literature, rates between 8-33% were observed in various studies (9, 21-25). Since the cases in our study did not include lung-based masses as in other literature but can only be reached by passing through the parenchyma, the low rate of progressive pneumothorax, which requires a chest tube, compared to the general percutaneous lung biopsy literature, can be considered as the success of the method (Table-4). In the study of Zaetta et al. (9), which is the only randomized study using the hydrogel plug system in support of this argument, the progressive case requiring a chest tube was found to be 20% in the hydrogel plug group and 34% in the control group.

In our study, we found a statistically significant relationship between age and the development of pneumothorax. This finding is similar to the literature (9). The decrease in lung compliance with age and the increase in emphysema with age are considered the main factors in this relationship. Also, smoking and its contribution to emphysema formation with age increase the risk of pneumothorax. Our study found no statistically significant relationship between pneumothorax and smoking history and emphysema. Studies state that emphysema, mentioned here as a factor, increases the risk of pneumothorax (8, 26). There are also studies saying that the presence of emphysema does not contribute to this risk (12). In this study, we documented patients with emphysematous changes in CT. The chronic obstructive pulmonary disease has not been investigated in depth in cases with radiologically normal-appearing parenchyma. However, the absence of a significant increase in complications in the patient subgroup with emphysematous changes suggests that the hydrogel plug method may have a protective effect in this group of patients. In our evaluations, a slight increase in the rate of pneumothorax in smokers compared to non-smokers draws attention.

Although some studies show no relationship between the lesion and the lung parenchyma distance in the development of pneumothorax (21, 23), it has been shown in many studies (8, 22, 26). In our research, the parenchymal distance passed in eight of 13 patients who developed pneumothorax was less than 2 cm. When the rates of pneumothorax within the parenchymal spaces were examined, similar values were found in the deeper lesions as percentages. Pneumothorax was more common in lesions where the distance between the pleura and the mass is less than 2 cm. It is thought that the reason for this is that the lesions located in the periphery make the lung parenchyma more vulnerable to damage due to excessive respiratory movements. According to a generally accepted hypothesis, more lung parenchyma is passed to reach deeper lesions, and the duration of the procedure is prolonged. At the same time, it is predicted that the pleura and lung parenchyma will be damaged more quickly, and the respiratory movements of the patient will facilitate the development of pneumothorax. In contrast, in the study of Cox et al. (26), it was determined that pleural passage was the primary factor in pneumothorax formation rather than parenchymal distance passed and that the space given did not cause a significant increase in the risk of pneumothorax.

When the relationship between pneumothorax and size was examined, pneumothorax was observed in 50% of lesions below 3 cm, 16.7% between 3-6 cm, and 28.6% of lesions above 6 cm. These rates were compatible with the literature data (8, 26). As a reason for this result, some authors show that parenchymal damage increases and contributes to the development of pneumothorax due to mechanical factors related to respiration since small lesions are more difficult biopsies, and the procedure remains in the parenchyma for a longer time (27). Another view is that in small lesions since automatic biopsy guns obtain a biopsy sample of 2 cm, the needle passing the lesion also damages the normal lung parenchyma, which is an additional factor in terms of pneumothorax (12).

Passing the fissure is considered an approach that should be avoided in the literature on the development of pneumothorax (28). However, due to the location of the lesion and anatomical formations that limit access, some biopsies can be obligatory. In our study, pneumothorax developed in 5 (71.4%) of 7 patients with fissures. The fact that the hydrogel plug line closure system we used could not prevent air leakage from the remaining pleural surfaces due to the fissure that only covered one pleural surface was the main reason for this result. Therefore, it should be kept in mind that using a line closing system may not be effective in cases where a fissure should be passed.

Due to the method used in our study, the size of the needle (19G introducer, 20G biopsy needle) and the way of taking biopsy material (semi-automatic incisor biopsy) were standard, so a statistical comparison could not be made with a variable based on these parameters. Geraghty et al. (23) found that using 19G needles decreased the pneumothorax rate by 50% compared to using 18G needles. In the study of Topal and Berkman (6), no statistically significant difference was found when pneumothorax rates of cutting needle biopsy and aspiration biopsy were compared. Apart from these factors, the literature indicates that the number of pleural passages also contributes to the development of complications (8). However, some studies found that the number of entries effectively reduced this complication

(26, 29). Our opinion is that using the coaxial system in transthoracic biopsies does not lessen the pneumothorax rate by reducing the number of entries. Still, it is a method that allows sufficient material to be taken through the system by opening a safe line.

Another complication was parenchymal hemorrhage, observed in our study's six (12%) patients. Hemoptysis developed in one (2%) of them, and this case did not progress to hemorrhage in the lung parenchyma after the observation and was discharged. This result is compatible with the rates of studies in which a biopsy was taken with a cutting needle in the literature (30). In five cases, parenchymal hemorrhage was mild and regressed spontaneously.

Massive pulmonary hemorrhage is very rare. While hemorrhage requiring treatment is mainly caused by the pulmonary artery or veins, massive hemorrhage is usually caused by the bronchial arteries. It should not be forgotten that another source of bleeding is intercostal arteries, and care should be taken during entry.

Rare complications of percutaneous transthoracic needle biopsies; include air embolism, massive hemoptysis, cardiac tamponade, malignant invasion in the biopsy trace, bronchopleural fistula, and lung torsion (31). In our study, none of the patients had signs suggesting vasovagal reaction, pulmonary torsion, air embolism, bronchopleural fistula, or cardiac tamponade during and after the procedure. The shortcomings of our study are that it did not include a large case series and cases in which the hydrogel plug system was not used as a comparison group. For this reason, conducting the study prospectively with a control group study and in large case series in a multi-centered manner will be more effective in determining the effectiveness of the promising hydrogel plug system. Also, in our case series, the presence of emphysema in patients is determined only by the data obtained from radiological observations. However, lung function tests can diagnose obstructive pulmonary disease, even if it is not proven radiologically. Some authors indicate obstructive pulmonary disease as an influential risk factor in the development of pneumothorax (31). Therefore, considering this risk, lung function tests should be determined as study parameters in future studies.

Although line closure is a theoretically accepted concept for preventing pneumothorax, there is no consensus method yet in the studies. When we evaluate the results, the Hydrogel plug application, a pneumothorax-preventing line closure system, is an easy, safe and acceptable method in percutaneous transthoracic biopsies performed with CT-guided coaxial cutting needles in non-pleural-based lung masses. We think that it can be applied easily in mediastinal masses. Another significant result obtained in our case series is that the main risk factors contributing to the development of pneumothorax are age and passing fissures. More studies are needed on the hydrogel plug system, which has many advantages in percutaneous transthoracic cutting needle biopsies.

Ethical Approval: Our study was carried out with the approval of Uludağ University Faculty of Medicine Research Ethics Committee dated 11 January 2011 and numbered 2011-2 / 6.

Author Contributions:
Concept: H.K., C.E.
Literature Review: H.K.
Design : H.K., C.E.
Data acquisition: H.K., C.E., G.Ö.
Analysis and interpretation: G.Ö.
Writing manuscript: H.K., C.E.
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