MARMARA
MEDICAL JOURNAL

Original Article

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# CT-guided lung biopsy: diagnostic accuracy and complication rates of biopsy techniques

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**Submitted:** 27.11.2021 **Accepted:** 24.03.2022

ABSTRACT

Objective: We aimed to evaluate the diagnostic accuracy and complication rates of computed tomography (CT)-guided core needle biopsy and fine needle aspiration biopsy (FNAB).

Materials and Methods: Patients who underwent CT-guided lung mass biopsy were included. The patients were evaluated in terms of age, gender, lesion diameter, lesion localization, depth of the mass, type of biopsy procedure (core needle biopsies and FNAB).

Results: The accuracy rate of FNAB in diagnostic material was found to be 100% in terms of benign, malignant and all lesions. The specificity and sensitivity of FNAB was found to be 100%. The diagnostic accuracy rate of core needle biopsy was found to be 70% in benign lesions, 100% in malignant lesions. The specificity of core needle biopsy was 90% and sensitivity 100%. There was no statistically significant difference between the two biopsy techniques in terms of complications.

Conclusion: In conclusion, we found that the diagnostic rates of FNAB and core needle biopsy were close in malignant lesions, the diagnostic rate of core needle biopsy was higher in benign lesions, and there was no difference in terms of complications in both biopsy techniques.

Keywords: Lung, Mass, Transthoracic biopsy, Computed tomography

## 1. INTRODUCTION

Transthoracic biopsy is frequently used for lesions that cannot be reached by bronchoscopy.

Compared to thoracic surgical biopsy, transthoracic biopsy is less invasive, has lower mortality and morbidity, and has lower requirement for hospitalization after biopsy [1,2].

Computed tomography (CT) has a very important role in the diagnosis of lung diseases as well as in biopsy. CT has become an indispensable modality in lung biopsies in recent years due to its advantages such as characterization of the lesion, including its relationship with neighboring structures and its distance to fissure, as well as early detection of post-biopsy complications. Transthoracic lung biopsy can be performed as core or fine needle aspiration biopsy (FNAB). Fine calibrated needles are used in FNAB, and the aspirated material is taken for cytological evaluation. Core biopsy is known as fragmentation biopsy and it is based on removing a piece of tissue from the lesion for histological diagnosis [3-6].

In this study, we aimed to evaluate the diagnosis and complication rates of both procedures in patients who underwent CT-guided trasthoracic core biopsy and FNAB.

## 2. MATERIALS and METHODS

Our study is a retrospective archive study, and patients who underwent CT-guided transthoracic biopsy between April 2015 and March 2020 were included in the study. This study was approved by Dicle University Ethical Committee (approval number: 88).

The patients were evaluated in terms of age, gender, mass diameter, mass localization, depth of the mass, and type of

**How to cite this article:** Deniz MA, Cakir C, Kurt O, Kilinc F, Deniz Tas Z. CT-guided lung biopsy: diagnostic accuracy and complication rates of biopsy techniques. Marmara Med J 2022; 2; 35(2):219-224. doi: 10.5472/marumj.1120552


ISSN: 1309-9469

http://doi.org/10.5472/marumj.1120552
**Marmara Med J 2022;35(2): 219-224**

biopsy performed (core biopsy or FNAB). Pneumothorax and parenchymal hemorrhage were evaluated as complications in the images taken after the biopsies.

Biopsies that were not finalized due to the patient's inability to adapt to the procedure, procedures whose images were not in our system despite the biopsy having been performed, patients without pathological diagnosis after biopsy, and procedures without control images in terms of biopsy complications were excluded from the study. In addition, because of the lack of control CT images of early postoperative complications, ultrasonography (US)-guided biopsies were also excluded from the study.

Before the procedure, hemogram and bleeding parameters were checked routinely in each patient. Patients using antiaggregant and anticoagulant drugs underwent biopsy after the treatment was interrupted. Intravenous vascular access was established in the patients, and the patients were taken into the procedure, preferably following 6-8 hours of fasting. Vital functions of the patients were monitored and oxygen saturation was followed closely. Before the procedure, a CT image was taken to see the current status of the mass. The patients were placed in the supine, prone, or lateral position so that the mass was visible, no fissures were passed, and a safe entry angle was minimally passed through the parenchymal area. The most suitable angle for access to the mass was determined. Under sterile conditions, local anesthesia was performed at the entry site with an average of 8-10 cc of 2% lidocaine, keeping it away from the pleura due to the risk of pneumothorax. Then, at an angle that would not pass fissure, a semi-automatic coaxial needle was sent as a 18G needle in patients who underwent core biopsy, and a 22G Chiba needle up to the mass level in patients who underwent FNAB. The needle tip was checked with serial images. Pleural leaves were not crossed more than once due to the risk of pneumothorax. In fine needle aspiration biopsies, aspiration was performed by moving the needle with the help of an injector. In core biopsies, after entering the mass, the inner needle was removed and an 18G cutting needle was sent through the coaxial needle and at least two samples were taken. Control CT imaging was performed in terms of early complications after the biopsy and control chest radiography was performed at 2, 4, 6, and 24 hours after biopsy.

### Statistical Analysis

Statistical Package for Social Sciences (SPSS) 22.0 program was used for statistical analysis. Categorical data are shown as numbers and percentages, measurement data as mean and standard deviation, lesion diameter and needle entry length data as median (interquartile) Chi-square analysis was used to compare categorical data. While evaluating the study data, the suitability of the parameters to the normal distribution was evaluated using the Kolmogorov-Smirnov test. In comparison of paired groups in quantitative data, independent groups t-test and Mann-Whitney U test were used. Pearson's correlation analysis was used to compare the two metric data. Significance was evaluated at the $p < 0.05$ level.

## 3. RESULTS

The mean age of the 142 patients included in the study was found to be 64.0 ± 11.6 (39-94) years. The median of the masses in the lung was 29 mm (19.7-40.0), and the lung distance to reach the mass was 16.0 mm (5.0-29.0).The masses were most commonly located in the upper lobe of the right lung (Table I).

Fine needle aspiration biopsy was performed in 60 (42.3%) patients, and core biopsy was performed in 82 (57.7%) patients. As a result of the biopsy, 28 (19.7%) were diagnosed as benign and 95 (66.9%) as malignant, while the material taken in 19 patients (13.4%) was non-diagnostic. While the definitive diagnosis of 34 (23.9%) of the patients was benign, the definitive diagnosis of 108 (76.1%) was determined as malignant (Table I).

***Table I.*** *Clinical and pathological features of the cases*

| | | Number | % (Percent) |
|---|---|---|---|
| **Age (years), Average±SD** | | 64.0±11.6 | |
| **Size (mm), Median (IQR)** | | 29 (19.7-40.0) | |
| **Lung distance to reach the mass (mm), Median (IQR)** | | 16.0 (5.0-29.0) | |
| **Location** | Right | 89 | 62.7 |
| | Left | 53 | 37.3 |
| **Lobar location** | Right lung upper lobe | 40 | 28.1 |
| | Right lung middle lobe | 11 | 7.7 |
| | Right lung lower lobe | 38 | 26.7 |
| | Left lung upper lobe | 21 | 14.7 |
| | Left lung lingual | 7 | 5.0 |
| | Left lung lower lobe | 25 | 17.6 |
| **Hemorrhage** | Yes | 8 | 5.6 |
| | No | 134 | 94.4 |
| **Pneumothorax** | Yes | 14 | 9.9 |
| | No | 128 | 90.1 |
| **Biopsy technique** | FNAB | 60 | 42.3 |
| | Core biopsy | 82 | 57.7 |
| **Biopsy result** | Benign | 28 | 19.7 |
| | Malignant | 95 | 66.9 |
| | Non-diagnostic | 19 | 13.4 |
| **Definitive diagnosis** | Benign | 34 | 23.9 |
| | Malignant | 108 | 76.1 |

*IQR: Interquartile range*

### *Fine needle aspiration biopsy*

The material taken from 11 (18.3%) of 60 patients who underwent FNAB was non-diagnostic. Pathology reports of 8 patients (13.3%) who underwent FNAB were reported as benign. In imaging and clinical follow-up, wedge resection or histopathological examinations performed after surgery, all 8 patients were found to be benign. Histopathological examination of 41 patients (68.3%) who underwent FNAB was reported as malignant. Malignancy was found in all of these patients on histopathological examinations performed after wedge resection or surgery. When non-diagnostic biopsies were excluded, the


http://doi.org/10.5472/marumj.1120552
Marmara Med J 2022;35(2): 219-224

accuracy rate of FNAB in diagnostic material was found to be 100% in terms of benign, malignant, and all lesions. At the same time, the specificity and sensitivity of FNAB was found to be 100%. Seven (63.6%) of the masses of the 11 non-diagnostic biopsies were benign and four (36.4%) were malignant. When all patients undergoing FNAB procedure were evaluated, 41 of 45 malignant lesions (91.1%) and 8 of 15 benign lesions (53.3%) were diagnosed correctly, and the total accuracy rate was found to be 81.6% .

### *Core biopsy*

The material taken from 8 (9.7%) of 82 patients who underwent core biopsy was not diagnostic. Pathology reports of 20 patients (24.3%) who underwent core biopsy were reported as benign. Of these, 14 who were evaluated as benign as a result of core biopsy in imaging and clinical follow-ups, were proven to be benign after wedge resection or postoperative histopathological examinations, while 6 patients had false negative results and a diagnosis of malignancy was made. Malignancy was reported in the histopathological examination of 54 patients (65.8%) who underwent core biopsy. Malignancy was detected in all of these patients on histopathological examinations performed after wedge resection or surgery. When non-diagnostic biopsies were excluded, the diagnostic accuracy rate of core biopsy was found to be 70% in benign lesions, 100% in malignant lesions and 91.9% in terms of all lesions. At the same time, the specificity of core biopsy is 90% and sensitivity was found to be 100% (Table II). For the 8 patients for whom insufficient material for diagnosis was obtained, 5 (62.5%) were diagnosed as benign and 3 (37.5%) were diagnosed as malignant. Considering all masses with core biopsy, 54 of 61 malignant lesions (88.5%) and 16 of 21 benign lesions (76.1%) were diagnosed correctly, and the overall accuracy rate was 73.1% (Table II).

***Table II.*** *Diagnostic values of FNAB and core biopsy techniques according to final (pathology result after resection, clinical follow-up, re-biopsy of the masses) diagnosis*

| | Resection, Pathology result after Clinical follow-up (GOLD STANDARD) | |
|---|---|---|
| **FNAB** | **Malignant** | **Benign** |
| **Malignant** | 41 **(91.1%)** | 0 |
| **Benign** | 0 | 8 **(53.3%)** |
| **Non-diagnostic** | 4 | 7 |
| **Total** | 45 | 15 |
| **CORE BIOPSY** | **Malignant** | **Benign** |
| **Malignant** | 54 **(88.5%)** | 0 |
| **Benign** | 6 | 14 **(76.1%)** |
| **Non-diagnostic** | 3 | 5 |
| **Total** | 61 | 21 |

Since 11 of the patients whose biopsy results were found to be benign were not followed up in our center, their files could not be accessed. Seven of the patients with benign lesions, were operated, and 16 were treated and followed up. In our system, the follow-up period of 23 patients with surgery, medical treatment, and follow-up was between 9 and 44 months, with an average of 22.6 months.

While no significant difference was found between the two techniques in terms of diagnosis rates in malignant lesions ($p>0,05$), core needle biopsy was found to be significantly higher in the diagnosis rate in benign lesions ($p<0.05$). There was no significant difference between the two techniques in terms of complications.

### *Final diagnosis*

In patients who could not be diagnosed with fine needle aspiration biopsy and core needle biopsy, the definitive diagnosis was made by open surgical biopsy resection, clinical follow-up, or re-biopsy. All of the lesions of the patients diagnosed in clinical follow-ups were benign, and the absence of a significant increase in size in these lesions, the clinical and laboratory features of clinical and laboratory features not suspicious for malignancy, and the shrinkage or disappearance of the lesions due to medical treatment removed them from malignant features. Diagnosis was made by core needle biopsy in 6 patients, open surgical biopsy-resection in 2 patients, and clinical follow-up in 3 patients for whom fine-needle biopsy did not provide an adequate diagnosis. Open surgical biopsy-resection was performed due to the high clinical suspicion of malignancy in benign lesions.

Open surgical biopsy was performed in 5 of 8 patients who were underdiagnosed in core needle biopsy, and biopsy was repeated in 3 of them. Of the 6 patients with false negatives in core biopsy, a definitive diagnosis was made as a result of re-biopsy in 4, open surgical biopsy-resection in 2 patients. Five of these patients were diagnosed with lung cancer, and one as metastasis.

The reasons why the diagnosis could not be made in the first biopsies in patients diagnosed in biopsy repetitions; biopsy from the necrotic area, biopsy from the adjacent lung parenchyma, not from the level of the mass, and biopsy from the place where there is no involvement in terms of malignancy in positron emmision tomography (PET)-CT.

### *Complications*

Pneumothorax and pulmonary hemorrhage were evaluated as complications, and hemorrhage was observed in 8 (5.6%) patients and pneumothorax was observed in 14 (9.9%). Hemorrhage was observed in 2 (3.3%) patients who underwent FNAB and 6 (7.3%) patients who underwent core biopsy. Pneumothorax was seen in 8 (13.3%) patients who underwent FNAB and 6 (7.3%) patients who underwent core biopsy. There was not a significant difference between the complication development of the cases according to biopsy technique. Likewise, there was not a significant difference between the technique applied and the size of the mass and the distance traveled to reach the mass (Table III).


http://doi.org/10.5472/marumj.1120552
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*Table III. Comparison of complication development status and masses of cases according to the techniques*

| | | FNAB | Core | p |
|---|---|---|---|---|
| | | Number (%) | Number (%) | |
| Hemorrhage | Yes | 2 (3.3) | 6 (7.3) | 0.476 |
| | None | 58 (96.7) | 76 (92.7) | |
| Pneumothorax | Yes | 8 (13.3) | 6 (7.3) | 0.235 |
| | None | 52 (86.7) | 76 (92.7) | |
| Size (mm), Median (IQR) | | 28.5 (20.0-38.0) | 30.0 (19.0-41.0) | 0.667 |
| Lung distance to reach the mass (mm), Median (IQR) | | 20.5 (8.5-30.0) | 14.0 (5.0-26.0) | 0.199 |

*IQR: Interquartilerange*

According to the development of hemorrhage or pneumothorax, no significant relationships were found between age, mass size, lung distance to reach the mass, and definitive diagnosis ($p > 0.05$) (Table IV).

In the biopsy results of the cases, no significant relationship was found between the diagnostic and non-diagnostic material and the size of the masses and the lung distance through which the needle passed ($p > 0.05$).

*Table IV. Comparison of age, size, distance and definitive diagnoses of the cases according to their complications*

| | Hemorrhage | | p | Pneumothorax | | P |
|---|---|---|---|---|---|---|
| | Yes | No | | Yes | No | |
| Age (years), Average±SD | 64.1± 13.5 | 64.0± 11.5 | 0.982* | 63.2± 11.6 | 64.1± 11.7 | 0.782* |
| Size (mm), Median (IQR) | 23.5 (17-29) | 30 (20-40) | 0.282** | 29.5 (25-32) | 29 (19-40) | 0.967** |
| Lung distance to reach the mass (mm), Median (IQR) | 21 (8.5-28) | 16 (5-29) | 0.825** | 25 (13-30) | 15.5 (5-27.5) | 0.238** |
| Benign, n (%) | 1 (12.5) | 33 (24.6) | 0.680 | 3 (21.4) | 31 (24.2) | 0.816 |
| Malignant, n (%) | 7 (87.5) | 101 (75.4) | | 11 (78.6) | 97 (75.8) | |

**t-test **Mann-Whitney U test. IQR: Interquartilerange*

## 4. DISCUSSION

In our study, in which we compared the diagnostic value and complication rates of FNAB and core biopsy in transthoracic lung biopsies; we found that the findings of two techniques were close to each other in malignant lesions while, core biopsy is more valuable in terms of diagnosis of benign lesions, and there was no significant difference between the two techniques in terms of complications. The diagnostic accuracy rates reported in the literature range from 65% to 96% due to changes in mean nodule size and modalities used for imaging guidance [6,7]. In their study, Yaffe et al., in core biopsies, found the accuracy rate as 94.4% in malignant lesions, 85.7% in benign lesions, and 93.6% in total [8]. In our study, the rate of patients diagnosed by biopsy was in accordance with the literature (86.6%).

It is reported that the positive diagnosis percentage of transthoracic FNAB is 70-100% in malignant lesions, while it is much lower in benign lesions, varying between 11-68%. In a study conducted by Çubuk et al., the overall diagnosis rate of FNAB was found to be 93% [9]. The sensitivity of FNAB for malignant lesions was 89%, specificity was 100%, and the accuracy rate was 95%. For benign lesions, sensitivity was 42.9%, specificity was 100%, and accuracy was 94% [8,9]. When non-diagnostic biopsies were excluded in our study the accuracy rate, the specificity and sensitivity of FNAB in diagnostic material was found to be 100% in terms of benign, malignant, and all lesions.

The percentage of diagnosis with core biopsy is higher, especially in benign lesions, and varies between 60-85%. Although, it is not much different from FNAB in malignant lesions, core biopsy often provides sufficient material for immunohistochemical studies. Both techniques can sometimes be used as complements to each other [9]. . Considering all the masses that underwent core biopsy in our study,the total accuracy rate was 73.1%. In addition, the diagnostic accuracy rate of core biopsy was higher in malignant lesions. At the same time, specificity of core biopsy was 90% and sensitivity was found to be 100%.

The most common complication in transthoracic lung biopsy procedure is pneumothorax, and its frequency has been reported to vary from 22-45% in different studies. Pulmonary hemorrhage is the second most common complication, and its frequency has been reported to vary from 5-27% in studies. A small proportion of patients who develop pneumothorax during biopsy require a thoracic tube for drainage [10-16]. Studies have reported that the development of pneumothorax depends on many factors. The most important of these are the number of pleural needle insertions, the depth of the lesion, the size of the lesion, and whether the fissure was passed during the biopsy. Although, there are studies arguing that the deep location of the lesion in the lung parenchyma has an effect on the development of pneumothorax, Yeow et al., contrary to what is known, found a higher rate of pneumothorax when lesions are located in the subpleural region [17]. They stated that the reason for this was that the distance traveled by the needle was short and the needle could easily exit the lesion. Similarly, Arıba et al., found a weak relationship between the development of pneumothorax and the depth of the lesion [18]. Massive hemoptysis, hemopneumothorax, air embolism, and seeding during the biopsy trace in malignant lesions are less common complications [12-15]. In our study, pneumothorax was observed in 10% and hemorrhage was observed in 5.6% of all the biopsy procedures. No major complications such as massive hemoptysis or air embolism were observed in any of the procedures performed.

Although, there are studies indicating that FNAB has a lower complication rate compared to core biopsy, recent studies have shown that there is no significant difference between core biopsy and FNAB in terms of complication risk. Aktaş et al., found no significant difference between FNAB and core biopsy in terms


http://doi.org/10.5472/marumj.1120552
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of the risk of pneumothorax and hemorrhage development [19]. Similarly, Chami et al., found no difference between the risk of pneumothorax and FNAB and core biopsy in their study [20]. In our study, no significant difference was found between the complication development of the cases and the applied biopsy technique. Although, there was no significant difference in complications between the two biopsy techniques, we think that the FNAB technique is much safer in lesions close to large vascular structures. Also, there was no significant relationship between the distance covered and the size of the lesion and the complication. In the literature, we did not find any studies investigating the relationship between the diagnostic and non-diagnostic biopsy specimens and the size of the lesion and the lung distance the needle passes through. In our study, no significant relationship was found between the diagnostic and non-diagnostic material after biopsy and the size of the masses and the lung distance through which the needle passed (p>0.05).

There are several techniques that increase the diagnostic value in percutaneous lung biopsies. These include taking a biopsy from the mass itself, not from the adjacent lung parenchyma, taking the biopsy from the walls of the cavitary masses, taking the biopsy from the area with involvement in favor of malignancy in PET-CT, and firing the biopsy gun after entering the lesion while taking biopsy from pleural-based masses [10-16]. In our study, most of the reasons of false negative core biopsies are; not being taken from the area with malignancy in PET-CT and biopsy is taken from the necrotic areas of the masses. Of six patients with false negative core biopsy results, five of them were primary lung cancer and one was metastasis. Since the characteristics on imaging of the masses, the presence of patient age group, and risk factors suggested high malignancy in this group, further investigations were performed and findings in favor of malignancy were determined. We think that one or more of the above-mentioned factors are effective in both patients with false negative core biopsy results and patients with insufficient diagnostic material.

The most important limitation of our study is that it is retrospective. In addition, the relatively low number of cases, the exclusion of US-guided biopsies in which early postoperative complication CT images could not be evaluated, the low number of patients with FNAB, and the low number of benign lesions included in the FNAB procedure are also important limitations.

In conclusion, we found that the diagnosis rates of FNAB and core biopsy were close in malignant lesions, the diagnosis rate of core biopsy was higher in benign lesions, and there was no difference in terms of complications in both biopsy techniques. We think that both methods can be used easily in lesions that are considered to be malignant, and core biopsy should be preferred primarily in lesions that are considered benign.

## Compliance with the Ethical Standards

**Ethical Approval:** Ethical approval was obtained from the Dicle University Ethical Committee (approval number:88).

**Financial Support:** The authors have no relevant financial information to close.

**Conflict of Interest:** The authors have no potential conflicts of interest to disclose.

**Author Contributions**: AKD, CC and FK: Drafting of the work, AKD and OK: Concept and design of the study, ZTD and AKD: Data acquisition, OK: Statistical analysis, AKD, CC,FK,OK,FY and ZTD: Medical practices. All authors critically revised the manuscript, approved the final version to be published, and agreed to be accountable for all aspects of the work.

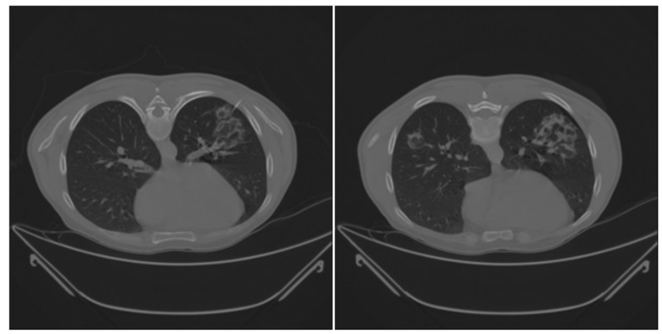

***Figure 1.*** *A 36-year-old male patient, in the prone position for the ground glass area in the lower lobe of the left lung, (a) FNAB and (b) Minimal pneumothorax is observed in the post-procedure control image (Diagnosis: Organized pneumonia)*

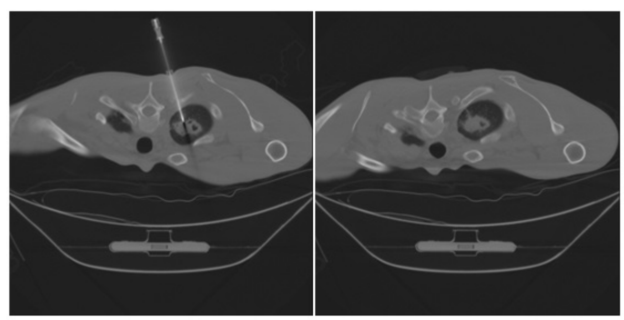

***Figure 2.*** *A 53-year-old female patient, in the prone position for a mass lesion containing cavitation in the upper lobe apical of the left lung, (a) core biopsy procedure and (b) minimal parenchymal hemorrhage in post-procedure control image (Diagnosis: Small cell cancer)*

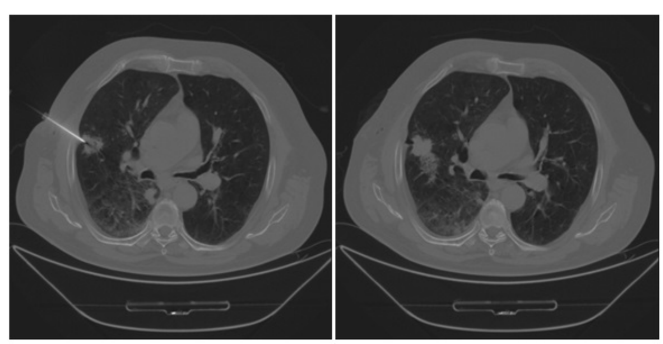

***Figure 3.*** *A 65-year-old male patient, in the supine position for nodular lesion in the right upper lobe (a) Tru-Cut biopsy procedure and (b) parenchymal hemorrhage in the post-procedure control image (Diagnosis: Adenocarcinoma)*

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