

Complications of CT-guided percutaneous lung biopsy

Complicaciones de la biopsia percutánea de pulmón guiada por tomografía

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DOI: <https://doi.org/10.53903/01212095.170>



Key words (MeSH)

Biopsy
Lung neoplasm
Pneumothorax
Computed tomography

Palabras clave (DeCS)

Biopsia
Neoplasias pulmonares
Neumotórax
Tomografía
computarizada

Summary

Introduction: Percutaneous computed tomography-guided biopsy (PCTGB) is a widely used procedure for the diagnosis of lung masses. Knowledge of its complications and their relationship with individual variables is vital to perform the procedure. **Objective:** To describe the complications of percutaneous lung biopsy (PLB) and their relation with the characteristics of the patients, the types of lesions and the approach used in our institution. **Materials and methods:** Retrospective descriptive study of 84 patients who underwent PCTGB between January 2016 and April 2019 in the Radiology department of the CES clinic in Medellín. **Results:** 17 patients presented complications, of which pneumothorax was the most common 13.1% (11/17), followed by alveolar hemorrhage 7.1% (6/17) and hemoptysis 4.8% (4/17). One of the patients died during the procedure. Patients with pulmonary comorbidities, especially emphysema, with small lesions, without adherence to the pleura, in the right lower lobe and with greater needle travel, had a higher rate of complications. **Conclusions:** In our clinic there are few complications related to PCTGB, the most common being pneumothorax, alveolar hemorrhage and hemoptysis, with percentages of 13%, 7% and 4.8% respectively, which are below known international reports

Resumen

Introducción: La biopsia percutánea guiada por tomografía computarizada (BPGTC) es un procedimiento ampliamente utilizado para el diagnóstico de masas pulmonares. El conocimiento de sus complicaciones y la relación de las mismas con variables individuales es vital a la hora de realizar el abordaje. **Objetivo:** Describir las complicaciones de la BPGTC y cómo estas se relacionan con características propias de los pacientes, los tipos de lesiones y la vía de abordaje utilizada en nuestra institución. **Materiales y métodos:** Estudio observacional retrospectivo descriptivo que incluyó 84 pacientes a los que se les realizó BPGTC entre enero de 2016 y abril de 2019 en el Departamento de Radiología de la Clínica CES, en Medellín. **Resultados:** 17 pacientes presentaron complicaciones, de las cuales el neumotórax fue la más común, 13,1 % (11/17), seguida de la hemorragia alveolar, 7,1 % (6/17) y la hemoptisis, 4,8 % (4/17). Uno de los pacientes falleció durante el procedimiento. Los pacientes con comorbilidades pulmonares, especialmente enfisema, lesiones de pequeño tamaño, sin adherencia a la pleura, en el lóbulo inferior derecho y con mayor recorrido de la aguja tuvieron un mayor número de complicaciones. **Conclusiones:** En nuestra institución hay pocas complicaciones derivadas de la BPGTC, y las más comunes son el neumotórax, la hemorragia alveolar y la hemoptisis con porcentajes del 13 %, 7 % y 4,8 % respectivamente, las cuales se encuentran por debajo de los estudios internacionales conocidos.

Introduction

Lung cancer is one of the leading causes of cancer deaths, accounting for 26-30 % of deaths worldwide (1). In Colombia it ranks second in overall cancer mortality in both sexes and accounts for approximately 12 % of deaths (2). Therefore, it is necessary to obtain an accurate histological diagnosis that directs treatment to lesions that are suspicious of malignancy.

Percutaneous biopsy guided by computed tomography (PCTGB) allows minimally invasive diagnosis of various pulmonary pathologies and in the context of malignancy, not only helps to confirm the diagnosis, but also provides the molecular profile of the tumor, which makes it possible to perform a personalized systemic therapy. Additionally, it can characterize other entities, such as infections that do not respond to treatment

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and inflammatory or fibrotic processes (3-6). It has a wide range of advantages and a low rate of complications (7).

It can be performed by fine needle aspiration or by cutting needle. The latter has a higher diagnostic yield, with accuracy rates of 95 %, sensitivity of 93 % and specificity of up to 98 % (7, 8).

With the sharp needle there may be a higher incidence of minor complications, including pneumothorax -which does not require intervention-, alveolar hemorrhage and hemoptysis. As for major complications, such as pneumothorax requiring intervention, hemothorax, air embolism and death, the frequency of presentation is equivalent between both types of biopsy (9, 10).

Currently, PCTGB is a widely known and used procedure. In the institution where the study was performed, the sharp needle method is used; however, there are few reports of complications in the country. There is a descriptive study that referred to the clinicopathological characteristics of pulmonary nodules, in which pneumothorax is mentioned as one of the complications, without going deeper into the subject (11). Therefore, the objective of the present study is to describe the complications and their relationship with the characteristics of the patients, the lesions and the approach with the technique used in the institution.

Materials and methods

A descriptive study was performed with patients of legal age who required tomography-guided lung biopsy from January 2016 to April 2019, without any type of pathological discrimination. No sample size calculation was performed as this was a retrospective study, with patients being admitted consecutively according to the need for biopsy.

This is a descriptive study through which the characteristics of the population submitted to PCTGB are reviewed and those that could be related to its complications are identified; the study aims to explore the particularities of the affected population and the factors that merit continuing a line of research to facilitate the identification of factors associated with better or worse outcomes derived from the intervention.

The patients were identified through the database of the Radiology Department of the institution where the study was performed. All patients who underwent PCTGB in the aforementioned period were taken into account and data were obtained from medical records; demographic and clinical variables, laboratory and pathology results, and radiological findings were recorded. The study was approved by the institutional ethics committee.

A retrospective analysis was made of 84 patients who underwent PCTGB of lung lesions performed between January 2016 and April 2019. As inclusion criteria, all lung biopsy specimens with pathology results were considered and patients with mediastinal masses were excluded.

The following variables were taken into account: the adequacy of the sample, the needle gauge and the use or not of coaxial, pulmonary comorbidity, the size of the lesion, the distance through the lung parenchyma before reaching the lesion, complications after the procedure and their treatment.

The terms mortality and death (final destination) were differentiated, of which the former is caused by the intervention and the latter by the underlying pathology.

The procedures were performed by radiologists with more than five years of experience and radiology residents under their supervision, with prior informed consent signed by the patient, review of coagulation times and blood platelet values.

Patient demographics, lung lesions and biopsy procedures are shown in Table 1.

Table 1. Demographic characteristics

Characteristics	Number and percentage of patients (n = 84)
Sex	
Male	50 (59.5 %)
Female	34 (40.5 %)
Age	
19-40 years old	9 (10.7 %)
41-60 years old	11 (13.1 %)
> 60 years old	64 (76.2 %)
Baseline disease	
COPD	20 (23.8 %)
Pulmonary tuberculosis	4 (4.8 %)
Emphysema	53 (63.1 %)
Pneumonia	3 (3.6 %)
Asthma	1 (1.2 %)
Neoplasm	3 (3.6 %)
None	60 (71.4 %)
Paraclinicals	
PT	
Normal	55 (65.5 %)
Abnormal	29 (34.5 %)
INR	
Normal	84 (100 %)
Abnormal	0 (0.0 %)
PTT	
Normal	46 (54.8 %)
Abnormal	38 (45.2 %)
Lesion size	
0-20 mm	16 (19.0 %)
21-40 mm	29 (34.5 %)
> 41 mm	39 (46.4 %)
Lesion location	
Right superior lobe	16 (19.0 %)
Middle lobe	6 (7.1 %)
Right lower lobe	24 (28.6 %)
Left superior lobe	15 (17.9 %)
Left inferior lobe	23 (27.4 %)

Lesion adhesion	
Pleural	40 (47.6 %)
Cisural	15 (17.9 %)
Both	12 (14.3 %)
Non-adherent	17 (20.2 %)
Cavitated lesion	
Yes	8 (9.5 %)
No cavitated lesion	76 (90.5 %)
Distance crossed	
0 mm	43 (51.2 %)
0,1-20 mm	29 (34.5 %)
21-40 mm	8 (9.5 %)
> 41 mm	4 (4.8 %)
Patient position	
Supine	25 (29.8 %)
Lateral	53 (63.1 %)
Prone	5 (6.0 %)
Lost	1 (1.2 %)
Approach	
Intercostal	73 (86.9 %)
Interscapular	8 (9.5 %)
Transscapular	2 (2.4 %)
Lost	1 (1.2 %)
Coaxial technique	
Yes	70 (83.3 %)
No	13 (15.5 %)
Missing	1 (1.2 %)
Sample Sufficiency	
Sufficient	79 (94 %)
Insufficient	5 (6.0 %)

n: Number; PT: Prothrombin time; PTT: Partial thromboplastin time; Missing: Cases without data.

Procedure

Initially, the radiologists who performed the procedure reviewed the previous tomographic images to delimit the area of interest, define the most appropriate position for the biopsy (supine, lateral or prone) and the most convenient approach (interscapular, intercostal or transscapular).

Then, they marked the puncture site using barium dots on the skin of the thorax as a reference and then took the necessary distances to reach the lesion, guided by tomographic images. At the time of performing the procedure, they infiltrated with 10 cm3 of lidocaine 2 % and used Trucut type needles of different calibers, using or not, coaxial technique according to the criteria of each radiologist.

The coaxial technique consists of the initial introduction of a needle in the proximal end of the lesion to be biopsied; this needle is the largest gauge. A second, thinner needle passes through it and protrudes far enough to take the samples. This method makes it possible to acquire several samples in a single puncture.

By means of a cut in the skin they introduced the needle into the lesion, verified that the needle was in the right place and took the lung tissue samples to be sent to the pathology laboratory.

The patients were left under surveillance for 2 to 3 hours and control X-rays were only taken in patients who presented symptoms such as hemoptysis or dyspnea after the procedure. The optimal management decision was made in conjunction with the general surgery team (thoracostomy, aspiration or resuscitation). If urgent intervention was not required, the patient was managed expectantly. Only one patient required cardiocerebropulmonary resuscitation after an immediate complication of the procedure (massive hemoptysis); after care, he died.

Data collection and analysis

The electronic medical records of patients who underwent CT-guided lung biopsy from January 2016 through April 2019 were reviewed to verify pulmonary comorbidity (asthma, pulmonary emphysema, pneumonia, or neoplasia).

The tomography images of the procedures performed were reanalyzed to establish the distance traversed of lung parenchyma in millimeters (mm); “0 mm” was determined for lesions that were in intimate contact with the pleura. Likewise, the diameter of the lesion was verified, it was determined if it was a cavitated lesion, if it was adherent to the pleura, immediate complications (reviewed in the patient’s clinical history) and the management of these at the time of presentation.

The pathology reports were reviewed and based on their results the definitive diagnosis was determined, which allowed dividing them into 5 categories: tumor, infectious, infiltrative, inflammatory or normal. Additionally, the final destination of the patient was taken into account, as well as the total days of hospital stay and those recorded after the procedure was performed.

All the data were recorded in an Excel database, cleaned and organized, and then processed with SPSS version 21 software; absolute and relative frequencies were calculated for each of the study variables.

For data analysis, descriptive statistical tools were used with frequencies and proportions for qualitative variables, medians and interquartile ranges for quantitative variables.

Results

Between January 2016 and April 2019, 84 PCTGB of lung lesions were performed in the Radiology service in 89 patients with suspicion of various lung lesions (neoplasia, infection, infiltrative or lymphoproliferative disease). Three patients were excluded because they did not have a definitive pathology report and two because of mediastinal and non-pulmonary lesions.

Eighty-four patients were admitted to the study with an average age of 67 years, most of them male (59.5 %); all 84 patients had undergone biopsy. The presumptive diagnosis at admission was lung

mass or nodule in two thirds of the population studied (58.3 % lung mass and 11.9 % lung nodule).

Regarding pre-procedural paraclinical tests, one third of the patients had an abnormal PT (34.5 %), with an abnormal PTT in about half of the patients (45.2 %) and a normal INR in all of them. Of the patients, 71.4 % had some type of pulmonary comorbidity: emphysema, asthma, pneumonia, pulmonary tuberculosis or neoplasia (defined as relevant at the authors' discretion). In addition, a quarter of the patients had a diagnosis of COPD or pulmonary tuberculosis (TB) (23.8% COPD and 4.8% TB) at the time of biopsy.

Of the total number of biopsies performed, 78 were in lateral or supine decubitus (63.1 % and 29.8 %, respectively) with intercostal approach in 86.9 % of the patients, using coaxial technique in 70 of the biopsies (83.3 %) (Figure 1). The 80.9 % of the patients had lesions larger than 21 mm; with anatomical location predominating in the right lower lobe in 28.6 % (24 patients) and left lower lobe in 27.4 % (23 patients). Most of the lesions were located at distances of less than 20 mm from the pleura (85.7 %); 90.5 % had no cavitations and 79.8 % had some type of adhesion to the pleura, the cisci or both structures. A sufficient pathology sample was obtained for analysis in 79 patients (94 %).

There were complications in 17 patients, 11 (13.1 %) of them with pneumothorax as a complication (Figure 2), 3 required chest tube passage for treatment (Figure 3), 6 (7.1 %) had alveolar hemorrhage (Figure 4), of which 4 (4.8 %) additionally presented hemoptysis, 1 of the patients with alveolar hemorrhage and hemoptysis died during the procedure (Table 2).

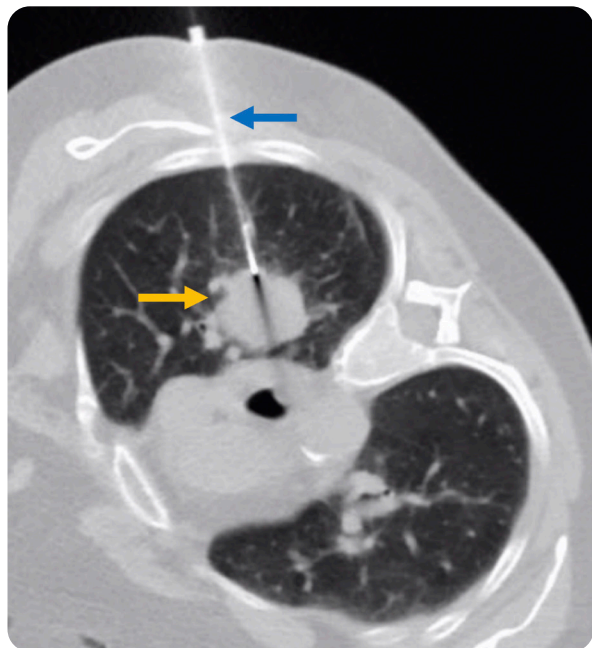


Figure 1. 72-year-old patient with left upper lobe mass (yellow arrow). He underwent percutaneous biopsy guided by tomography with coaxial technique (blue arrow). The patient had no complications. The diagnosis was moderately differentiated adenocarcinoma.

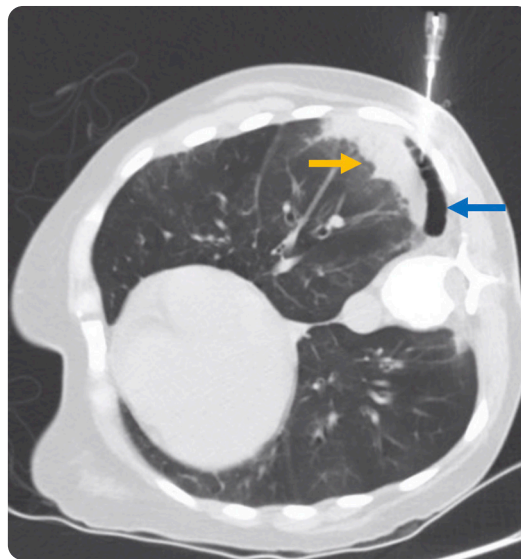


Figure 2. 53-year-old patient with diagnosis of pneumonia. Percutaneous biopsy of left basal consolidation (yellow arrow), by coaxial technique. After the first needle pass, she developed a small pneumothorax of less than 10% (blue arrow), which did not require intervention. The result of the histological study was atypical lymphoid proliferation.

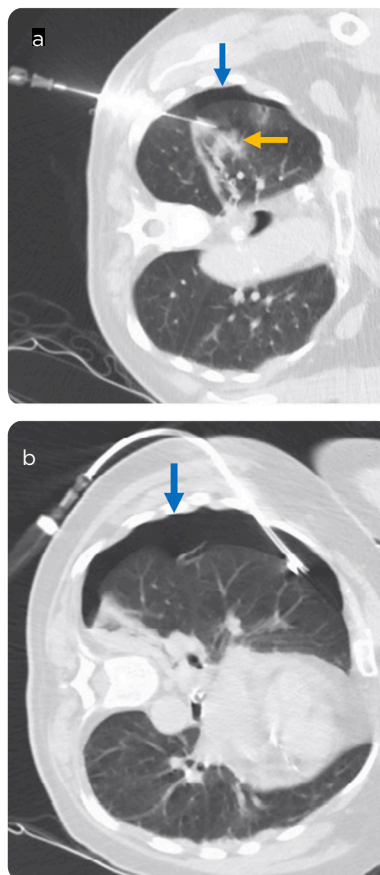


Figure 3. 75-year-old patient. a) Percutaneous biopsy of right upper lobe mass (yellow arrow). After the first pass of the needle she developed a small pneumothorax (blue arrow). b) In the tomographic control there was an increase in the pneumothorax (blue arrow), it was managed with a chest tube.

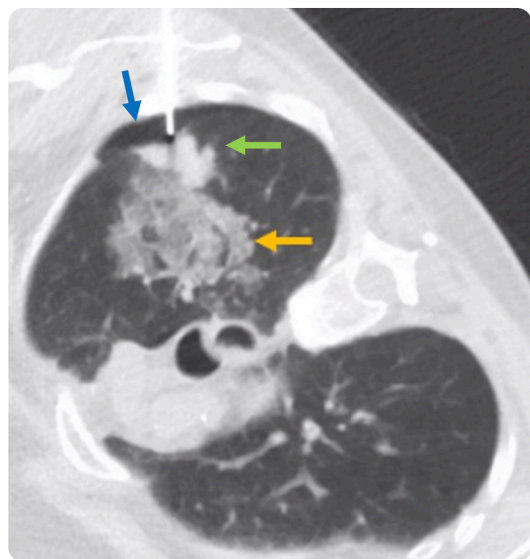


Figure 4. 76-year-old patient with left upper lobe mass (green arrow). CT-guided percutaneous biopsy. Adjacent to the mass (yellow arrow): ground-glass area that appeared after the first sample was taken and corresponds to alveolar hemorrhage. Additionally, a small pneumothorax is observed (blue arrow). The patient presented hemoptysis, with expectant management without progression of complications. The histologic diagnosis was moderately differentiated adenocarcinoma.

Most of the patients with complications did not undergo treatment and were managed expectantly (11 patients), while the other 6 patients did require some type of intervention related to the complication, defined at the discretion of the treating physicians, the mention of which is beyond the scope of this study. The median number of days of hospitalization related to the diagnostic intervention (lung biopsy) was 3.5 days.

Table 2. Complications related to sharp needle lung biopsy

Complication	Number and percentage of patients
Pneumothorax	
Yes	11 (13.1 %)
No	73 (86.9 %)
Alveolar hemorrhage	
Yes	6 (7.1 %)
No	78 (92.9 %)
Hemoptysis	
Yes	4 (4.8 %)
No	80 (95.2 %)
Death	
Yes	1 (1.2 %)
No	83 (98.8 %)

There were no significant differences in the rate of complications in relation to sex; in men it was 47.1% and in women 52.9%. Regarding pulmonary comorbidity, it was found in 10 of the 17 patients who had complications (58 %), as described in Table 3. Regarding the procedure, it was identified that in the lateral position there was a higher rate of complications: 15 patients (88.2 %); however, it should be considered that it was also the most used position in all procedures.

Regarding the size of the lesion, the range in which there were more complications was 21-40 mm with 8 patients (47.1 %), the most common location of the lesion was in the right lower lobe with 7 patients, who presented complications (41.2 %). In cavitated lesions there was a low rate of complications: 2 patients (11.8 %). Lack of adherence of the lesion to the pleura was associated with complications in 8 patients (47.1 %). The distance through the parenchyma was not associated with more complications and most occurred in patients with a final diagnosis of tumor lesion: 13 (76.5 %). There is a wide variety of histopathological findings that represent a lesion of neoplastic origin, which finally encompass the term “tumor lesion”.

Table 3. Comparison of patient, lesion and procedure characteristics with post-biopsy complications

Characteristics	Complication
Sex (male and female)	
Male	8 (47.1 %)
Female	9 (52.9 %)
Pulmonary comorbidity	
Asthma	
Present	1 (5.9 %)
Absent	16 (94.1 %)
Neoplasm	
Present	0 (0.0 %)
Absent	17 (100 %)
TBC	
Present	1 (5.9 %)
COPD	
Present	1 (5.9 %)
None of the above	15 (88.2 %)
Emphysema	
Present	7 (41.2 %)
Absent	10 (58.8 %)
Pneumonia	
Present	2 (11.2 %)
Absent	15 (88.2 %)
Use of coaxial technique	
Yes	15 (93.8 %)
No	1 (6.3 %)

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Position	
Supine	2 (11.8 %)
Lateral	15 (88.2 %)
Prone	0 (0.0 %)
Size of the lesion	
0-20 mm	4 (23.5 %)
21-40 mm	8 (47.1 %)
> 41 mm	5 (29.4 %)
Location of lesion	
Right superior lobe	5 (29.4 %)
Right middle lobe	0 (0.0 %)
Right lower lobe	7 (41.2 %)
Left superior lobe	4 (23.5 %)
Left inferior lobe	1 (5.9 %)
Approach	
Intercostal	13 (76.5 %)
Interscapular	3 (17.6 %)
Transescapular	1 (5.9 %)
Cavitated lesion	
Yes	2 (11.8 %)
No	15 (88.2 %)
Lesion adhesion	
Pleural	6 (35.3 %)
Cisural	2 (11.8 %)
Both	1 (5.9 %)
No adhesion	8 (47.1 %)
Distance crossed	
0 mm	2 (11.8 %)
0,1-20 mm	11 (64.7 %)
21-40 mm	4 (23.5 %)
> 41 mm	0 (0.0 %)
Definitive diagnosis	
Tumor	13 (76.5 %)
Infectious	0 (0.0 %)
Inflammatory	1 (5.9 %)
Normal	3 (17.6 %)

Discussion

Percutaneous core needle biopsy is a widely used procedure in thoracic oncology for the diagnosis of lung lesions, due to its low complication rate with a high technical and diagnostic success rate (10, 12, 13). Among its most common complications are pneumothorax, alveolar hemorrhage and hemoptysis, which most of the time do not require additional interventions (10, 13-16).

In the present study it was found that 17 of 84 patients (20.2 %) had complications related to the procedure, the most common being pneumothorax in 11 of them (13.1 %), 3 of whom required a thoracostomy tube. Previous studies have described an incidence of pneumothorax

between 9 % and 54 %, with an average of around 20 % (17, 18). In the study conducted by Mills et al. a pneumothorax rate of 25.7 % was reported, with 6.5 % requiring chest tube (4) and Min Choi et al. documented pneumothorax rates of 21.8 % (19), so the incidence observed in this study is within the values previously described and even lower than theirs.

When comparing the rate of complications with previous publications, it is evident that the study institution has a value within the average and even lower. In a study of complications by Cesar et al. they found a pneumothorax rate of 20.8 % and alveolar hemorrhage of 15.7 % (20); in another study published by Wattanasatesiri et al. they reported an incidence of pneumothorax and alveolar hemorrhage of 23.1 % and 45.4 %, respectively. Twenty-two percent of patients with pneumothorax required percutaneous drainage (21).

When other factors related to complications were analyzed in the present study, it was found that 10 patients of the 17 (58 %) had some comorbidity of pulmonary origin: asthma 1 (5.9 %), emphysema 7 (41.2 %), pneumonia 2 (11.8 %), COPD 1 (5.9 %) and tuberculosis 1 (5.9 %); emphysema appeared as the most common, but an association could not be determined. Previous publications have described a higher rate of complications in relation to emphysema or underlying infection (20,21), but there are other studies, such as the one carried out by Shiekh et al. in which emphysema did not represent a significant increase in the incidence of complications (22), which corresponds to what was found in the present study.

Regarding the use of the coaxial technique in the patients who had some complication, in 15 of 17 (93.8 %) its use was reported vs. 1 patient (6.3 %) in whom it was not used; however, it should be taken into account that in the great majority of the procedures (70 of 84) the coaxial technique was used, so this difference is not representative. In previous reports it has been found that pneumothorax is lower when the coaxial technique is not used, 23.2 % vs. 27 % when it is used (16); as well as the incidence of pulmonary hemorrhage, 19.6 % vs. 22.3 % (23). No statistically significant differences have been found (24), so the use or not of this technique does not have a significant impact on the presence of complications.

Regarding the size of the lesion, in the patients studied, lesions between 21-40 mm presented the most complications, 8 of 17 patients (47.1 %). In most of the known studies, size has not represented a significant risk factor for the appearance of complications (25); in other studies small lesions, smaller than 33 mm, have been related to an increase in complications (9, 14, 19, 21, 26), which can also be seen in the present study.

When analyzing the occurrence of complications with respect to the location of the lesions, it was found that 7 of 17 patients with complications (41.2 %) had the lesion in the right lower lobe, which is consistent with previous studies in which it has been reported that lesions in the right lower lobe and in the middle lobe present higher complication rates, with pneumothorax as the most frequent (27).

In relation to the adherence of the lesion to the pleura, it was identified that non-adherence represented complications in 8 of 17 patients (47.1 %), while in 6 of 17 (35.3 %) of those who had complications there was pleural adherence. Although the number of complications was higher in those without adherence, this did not represent a significant difference. It is noteworthy that previous studies have reported that a distance from the lesion to the pleura of 21 mm or more is a risk factor for complications (28).

The distance traveled with the needle to reach the lesion is also related to the occurrence of complications, as has been described (5, 21, 29); in the present work, distances between 0.1 and 20 mm were related to more complications in 11 of 17 patients (64.7 %).

The overall mortality rate was 1.25 % (1 patient), slightly higher compared to other studies in which the rate has been 0.16 % (30, 31); however, the number of patients studied here is small, which may explain this finding.

In this work, one limitation is the low number of procedures performed, which does not allow a statistically significant comparison between variables. Another limitation is that there were no fine needle aspiration biopsies to compare the performance of both techniques, although the literature is clear in stating that the diagnostic success rate with core needle is higher than fine needle aspiration biopsy, with a lower rate of major complications (32).

In conclusion, in the present study it was identified that in the institution where it was performed there is a low number of complications, the most common being pneumothorax, alveolar hemorrhage and hemoptysis with percentages of 13 %, 7 % and 4.8 %, respectively, which are below previous international reports. Additionally, it was observed that patients with pulmonary comorbidities, especially emphysema, with small lesions, without adherence to the pleura, in the right lower lobe and with greater needle trajectory presented more complications in agreement with previous known studies.

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Received for evaluation: March 17, 2021

Accepted for publication: July 20, 2021