

## CT GUIDED TRANSTHORACIC BIOPSY OBTAINED WITH CORE BIOPSY TECHNIQUE: SAFETY AND SUCCESS OF THE PROCEDURE

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Percutaneous Transthoracic Biopsy (TTB) is a minimally invasive method of obtaining tissue specimens from a previously detected thoracic lesion for further analysis in order to reach a definite diagnosis.

The study aimed at determining the role of percutaneous transthoracic biopsy in the light of current international recommendations for performing the intervention, and presenting our experiences - success rate, and complications.

The study included 57 patients (17 women and 40 men) of average 64.4 years, who underwent biopsy procedures from January 2016 to November 2019. The procedure was performed using the cutting biopsy technique, using an automated BARD MAGNUM Reusable Core Biopsy System with 14-18 G diameter needles, under the guidance of GE 16 and GE 64 MDCT, with a postprocedural scan for complication evaluation. The material was sent to the Pathology Clinic, Clinical Center Niš.

The procedure was successful in 53 patients (92.98%). Of the complications, pneumothorax was reported in 14 patients (24.56%), hemoptysis in 4 patients (7%), and intrapulmonary hemorrhage in 10 patients (17.54%). Only 4 cases of pneumothorax (7%) required drainage. The smallest lesion was 20 mm in diameter and the longest pathway through the lung parenchyma was 50 mm.

Based on our results, we can conclude that CT-guided transthoracic biopsy with core biopsy technique is a minimally invasive inexpensive procedure, with high rates of diagnostic accuracy, and acceptably low complication rates, and therefore one of the mandatory procedures to be considered in diagnosis of thoracic masses.

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**Key words:** *biopsy, percutaneous, transthoracic, computed tomography (CT), pneumothorax*

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### Introduction

With increased availability of spiral CT, a growing number of thoracic tumors is detected and they are still a diagnostic and therapeutic challenge in management of these lesions histological diagnosis is a prerequisite for treatment planning (1). While mediastinal tumors (most common being lymphomas, thymomas and metastases) and thora-

cic wall tumors are relatively rare (2, 3), lung cancer represents a growing problem, being second most frequently diagnosed cancer, accounting for 17% of all cancers in men and 9% in women, and a leading cause of cancer-related death worldwide (4).

Since percutaneous needle biopsy has yielded excellent results in multiple organ systems followed by few complications (5), it is expected to be very successful for thoracic lesions. Transthoracic biopsy is a minimally invasive procedure used to obtain samples from previously detected thoracic mass for further analyses, leading to definite diagnosis. While bronchoscopic lung biopsy is highly accurate for cytologic and histologic diagnosis of centrally located lesions, it is of limited value for peripheral lesions (6).

Therefore, often following inconclusive findings of bronchoscopy or having a peripherally located lesion, imaging guided transthoracic biopsy is used as a standard procedure. Image guidance is necessary for precise sampling, to make sure the needle is placed in correct position when obtaining the sample. While various imaging modalities can be used for image-guided interventions (fluoroscopy,

ultrasound, computed tomography and magnetic resonance), CT guidance is most frequently used, due to high spatial and contrast resolution of spiral multidetector CT, and availability of multiplanar and 3D reformations (7).

Although two basic methods are in use for obtaining samples, based on needle type, cutting needle biopsy provides higher diagnostic accuracy of benign lung lesions and equal diagnostic accuracy of malignant lung lesions compared to fine needle aspiration, risk of complications being within the acceptable range (8).

While considered minimally invasive and very safe, there are some complications reported following this procedure. Most common complications are pneumothorax (incidence ranging up to 54%, mean value 20%) (9) and major bleeding (incidence being 2.8%) (10), followed by rare complications - systemic air embolism (ranging from 0.01% to 0.21%) (11) and tumor seeding via biopsy tract. Most common complications often spontaneously resolve, but sometimes pneumothorax and major bleeding require prolonged hospitalization and additional intervention.

Having in mind reported diagnostic accuracy rates for cutting needle lung biopsy ranging from 76% to 93% (12), in this retrospective study we sought to evaluate CT-guided transthoracic biopsy results and safety, as performed in our institution.

## Materials and methods

From January 2016 to November 2019, transthoracic CT-guided cutting needle biopsy procedures were performed in 60 patients.

Prior to transthoracic biopsy procedures, all patients sent to biopsy were surveyed for contraindications. Since there are no absolute contraindications (8, 13), medical documentation was searched and patients with suspicion of vascular structure and hydatid cyst, and those unable to cooperate (positioning, cough control) were not included, while based on recorded platelet counts, prothrombin time, and activated thromboplastin time some of the patients were subjected to correction of coagulopathy.

Detailed information considering performing the procedure, possible complications, and treatment of these complications were explained to each subject.

Written informed consent was obtained from all patients.

Of the initial 60 subjects, 3 were excluded from the analysis because their records were incomplete or unavailable (since they had been referred from other centers for the biopsy procedure). The records of included patients were retrospectively evaluated.

All patients who underwent percutaneous transthoracic lung biopsy had one from the list of indications defined by Manhire et al. (13) in BTS guidelines:

1) new or enlarging solitary nodule or mass on the chest radiograph/CT which is unlikely to be

accessible by bronchoscopy/following insufficient bronchoscopy,

2) multiple nodules in a patient without known primary malignancy/with known primary malignancy and a prolonged remission,

3) persistent infiltrates, without diagnosis after sputum or blood culture analyses, serology or bronchoscopy,

4) hilar mass following negative bronchoscopy.

Thoracic CT scans of 57 patients were evaluated, and the size of the targeted lesions (the longest diameter) was recorded. Lesions were divided into two groups based on size (largest measured diameter  $\leq$  30 mm, and larger than 30 mm), and into two groups based on localization (peripheral and non-peripheral, lesion considered as peripheral if partly within 20 mm distance from visceral pleura).

All biopsies were performed by 2 interventional radiologists, on GE multidetector systems for computed tomography - GE 16 and GE 64.

Patients were positioned on the tomography table regarding the targeted lesion, to enable the shortest and safest route of the needle, in prone, supine position or lying on the side. CT scan was obtained with images of 1.25 to 2.5 mm thickness, and as narrow a field of view as possible while encompassing the targeted lesion. Appropriate measurements were taken, and after determining appropriate image slice, laser guidance system was used to define the exact site of puncture on the skin. Following cleaning and sterilization of the skin, local anesthetic was applied, and minimal incision was made to provide passage of the needle. A 14 G to 18 G needle was introduced at an appropriate angle to the lesion, with a tip of the needle at the border of the lesion. Samples were obtained by an automated BARD MAGNUM Reusable Core Biopsy System (C. R. Bard, Inc. Bard Medical, Covington, Georgia) with compatible Core Biopsy Needles (C. R. Bard, Inc. Bard Medical, Covington, Georgia) - three samples per patient, if possible, that were placed in a container with formalin solution and sent to the pathology laboratory for analysis.

Immediately after the biopsy procedure, control CT scans were performed, and a control chest X-ray 4 hours after the procedure. Complications were noted in reports.

If patients had no symptoms and no increase in the pneumothorax on follow-up, no intervention was performed. If a significant or rapidly enlarging pneumothorax was found, a chest tube was placed into the pleural space by a thoracic surgeon.

Complications (pneumothorax, bleeding, hemoptysis, etc.) and interventions necessary to treat them were noted. Frequency of complications was compared considering size and localization of lesions.

Transthoracic biopsy results were classified into 2 groups: diagnostic, and nondiagnostic results. The procedure was deemed successful if samples taken from the lesion provided enough material to reach the histologic diagnosis.

## Results

Transthoracic biopsy using a core biopsy system was performed on 60 patients. Complete records were available in 57 patients. The mean age of the patients was 64.4; 17 (28.33%) were female and 40 (66.67%) were male.

The longest axial diameter of targeted lesions varied from 20 mm to 65 mm.

Pathology results of transthoracic biopsy were achieved in all 57 patients (100%), of whom the results were diagnostic in 53 (92.98%). The pathology results were nondiagnostic in 4 patients (7%).

From lesions identified on thoracic CT, a mean of 2.5 biopsy specimens were obtained from each patient. In 1 patient with severe emphysema, pneumothorax developed on our second attempt, but the biopsy specimen was already obtained and it turned out that it was sufficient for diagnosis.

Complications were observed in 21 (36.84%) of 57 patients in whom a transthoracic biopsy was performed (several patients had combined complica-

tions). Pneumothorax developed in 12 patients (21.05%); a drainage tube was needed in 4 of them (7%), and procedure was performed by thoracic surgeon - surgery was not needed.

In patients with bleeding and hemoptysis, no additional therapeutic intervention was needed on follow-up. Intrapulmonary hemorrhage occurred in 10 (17.54%) and hemoptysis in 5 patients (8.77%). The complications detected after transthoracic biopsy are summarized in Table 1 compared to thresholds of good clinical practice and meta-analysis that included the largest number of transthoracic biopsies.

Statistical analysis used chi square test to correlate complications with lesion localization (Table 2) and size (Table 3), with contingency coefficient to assess intensity of correlation. Lesion size and lesion localization turned out to be in positive correlation with occurrence of pneumothorax major and minor, and intrapulmonary hemorrhage, while diagnosis was not affected by the presence or absence of complications.

**Table 1.** The complications detected after transthoracic biopsy

Complications of TTB		Good Clinical Practice (%)	Meta-Analysis (Heerink et al.) (%)	Our results	
				%	n
Pneumothorax		45	25.3	21.05	12
	Major PNX Thoracic Drainage	20	5.6	7.02	4
Hemorrhage	Hemoptysis	2	4.1	8.77	5
	IP Hemorrhage		18	17.54	10

**Table 2.** Lesion localization

		Localization		Total	$\chi^2$	Sig	C
		Non peripheral	Peripheral				
Pneumothorax Minor	No	11 (64.71%)	38 (95%)	49 (85.96%)	9.074	.003	.371
	Yes	6 (35.29%)	2 (5%)	8 (14.04%)			
Pneumothorax Major	No	14 (82.35%)	39 (97.5%)	53 (92.98%)	4.195	.041	.262
	Yes	3 (17.65%)	1 (2.5%)	4 (7.02%)			
Hemoptysis	No	15(88.24%)	37 (92.5%)	52 (91.23%)	.271	.603	.06
	Yes	2 (11.76%)	3 (7.5%)	5 (8.77%)			
Intrapulmonary Hemorrhage	No	9 (52.94%)	38 (95%)	47 (82.46%)	14.588	.000	.451
	Yes	8 (47.06%)	2 (5%)	10 (17.54%)			

**Table 3.** Lesion size

		Size		Total	$\chi^2$	Sig	C
		$\leq 30$ mm	> 30				
Pnx Minor	No	14 (70%)	35 (94.59%)	49 (85.96%)	6.509	.011	.320
	Yes	6 (30%)	2 (5.41%)	8 (14.04%)			
Pnx Major	No	16 (80%)	37 (100%)	53 (92.98%)	7.958	.005	.350
	Yes	4 (20%)	0 (0%)	4 (7.02%)			
Hemoptysis	No	19 (95%)	33 (89.19%)	52 (91.23%)	.548	.459	.098
	Yes	1 (5%)	4 (10.81%)	5 (8.77%)			
Intrapulmonary Hemorrhage	No	13 (65%)	34 (91.89%)	47 (82.46%)	6.490	.011	.320
	Yes	7 (35%)	3 (8.11%)	10 (17.54%)			

## Discussion

Following inconclusive findings of bronchoscopy or used as an initial procedure in patient workup, CT-guided transthoracic biopsy is a well established procedure to characterize thoracic, especially pulmonary lesions. Even though the results of both TTB and bronchoscopy depend on lesion size and location, and on individual skills of the physician performing the procedure (14-16), TTB has a higher sensitivity and specificity than bronchoscopy, being preferable test in diagnosing solitary nodules.

While reported success of fine-needle aspiration biopsies was up to 99% (17, 18) with a few complications, limitations were low sensitivity for benign lesions (being under 50%) (19), and inadequate or insufficient samples in up to 20% (20-22). Core biopsy is preferred by many authors as it provides high quality tissue samples more adequate for electron microscopy, immunohistochemistry and analysis of tumor-markers, enhancing diagnostic specificity (19, 23, 24). Therefore, we used cutting technique with automated core biopsy systems.

In our study, all lesions were equal to or larger than 20 mm (in measured diameter) and sufficient histologic material was successfully obtained from core specimens, even from lesions with pleural distance of more than 40 mm. Overall diagnostic accuracy was reported to be very high with 3 specimens obtained during every biopsy procedure (25), as in our study. In our study overall accuracy observed was 92.98 %, in accordance with numerous authors and appropriateness criteria. In 7% of our cases tissue samples were not diagnostic, reasons thought to be sampling mistakes - missed biopsies, sampling from necrotic center or peritumoral inflammatory zone.

CT-guided transthoracic cutting needle biopsy is safe; however, an overall complication rate was recorded to be 39.1% (26), encompassing pneumothorax, bleeding (pulmonary hemorrhage, hemoptysis), air embolism, tumor seeding via biopsy tract, infection and mortality.

Pneumothorax is the most common complication of CT-guided lung biopsy, varying from 8% to 64% (27), due to different factors, most important being depth of the lesion, emphysema, higher sensitivity of CT for diagnosis of pneumothorax. In our study pneumothorax was observed in 24.56% of patients, finding that was consistent with various authors (28, 29). Chest tube was placed in 4 (7%) of our patients, and it was also in agreement with previous results (8).

Hemorrhage remains the second most common complication of transthoracic biopsy, which can be life-threatening. Hemorrhage occurs in approximately 5% to 16.9% of patients undergoing percutaneous biopsy, rates going as high as 30% (29). Hemoptysis may follow, in 1.25% to 5% (30, 31). In

our study there were 5 patients with hemoptysis (8.77%) and 10 patients with intrapulmonary hemorrhage (17.54%). No major bleeding complication or hemothoraces occurred, and no transfusion, bronchoscopic tamponade, arterial embolization, or surgery were necessary.

While infection may follow in 2% of patients, air emboli (0.012-0.61%), tumor seeding via biopsy tract (0.02-0.4%) and mortality (0.16%) are extremely rare complications (32). None of these events was recorded in our study.

Previous studies have reported higher rates of complications, especially hemorrhage, for core biopsy systems than for fine-needle aspirates (33). Meta-analysis performed by Heerink et al. (32) confirmed higher rates of pneumothorax and hemorrhage (both intrapulmonary and hemoptysis) if using core biopsy system, and defined risk factors leading to complications, naming size of the needle, number of pleural passes and coaxial technique as very important. The most important yield of the meta-analysis was reporting that even though complications in general were more numerous in cutting biopsy group, the rate of major complications was similar to FNA biopsies. Heerink also concluded that, apart from needle size, common risk factors for major complications were size and depth of the targeted lesion. Our results revealed statistically significant correlation of complications (pneumothorax major and minor, intrapulmonary hemorrhage) with lesion localization (Table 2) and size (Table 3), suggesting non-peripheral lesions with diameter of 30 mm and smaller are associated with higher risk for developing complications after biopsy.

Apart from being accurate and safe procedure, it is also 6.3 and 10.9 times less expensive, compared to the costs of thoracoscopic surgery and thoracotomy, respectively (34). As a means to definite diagnosis, result of transthoracic biopsy proves to influence patient management, allowing for avoiding surgery in approximately 75% of patients (29).

## Conclusion

In our study, we showed that even though we used somewhat larger needles (14-18 G) compared to other authors (18-20 G), and no coaxial needle, complication rates were in agreement with previous studies. Diagnostic accuracy in our study was very high (92.98%). Based on our results and previous studies, we can conclude that CT-guided transthoracic biopsy with core biopsy technique is a minimally invasive inexpensive procedure, with high rates of diagnostic accuracy, and acceptably low complication rates, and therefore one of the mandatory procedures to be considered in diagnosis of thoracic masses.

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## **CT-OM VOĐENA TRANSTORAKALNA BIOPSIJA IZVEDENA TEHNIKOM CORE BIOPSIJE: BEZBEDNOST I USPEŠNOST PROCEDURE**

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Perkutana transtorakalna biopsija (PTTB) predstavlja minimalno invazivnu metodu, kojom se pribavlja uzorak tkiva iz uočene promene grudnog koša za dalju analizu, u cilju postavljanja dijagnoze.

Cilj ovog rada je utvrđivanje uloge perkutane transtorakalne biopsije, u svetlu trenutnih međunarodnih preporuka za obavljanje intervencije, kao i predstavljanje naših iskustava – stepena uspeha i komplikacija.

Studijom je obuhvaćeno 57 bolesnika (17 žena i 40 muškaraca) prosečne starosti 64,4 godine, koji su bili podvrgnuti procedurama biopsije od januara 2016. do novembra 2019. godine. Postupak je izvršen tehnikom CORE biopsije, korišćenjem automatizovanog BARD MAGNUM sistema za CORE biopsiju za višestruku upotrebu, iglama prečnika 14 G – 18 G, pod vođstvom GE 16 i GE 64 aparata za višerednu kompjuterizovanu tomografiju, uz postproceduralno skeniranje za procenu komplikacija. Materijal je potom upućivan na Kliniku za patologiju Kliničkog centra Niš.

Procedura je bila uspešna kod 53 bolesnika (92,98%). Od komplikacija zabeležen je pneumotoraks kod 14 bolesnika (24,56%), hemoptizije kod 4 bolesnika (7%) i intrapulmonalno krvarenje kod 10 bolesnika (17,54%). Samo 4 slučaja pneumotoraksa (7%) zahtevali su plasiranje drenažnog katetera. Najmanja lezija bila je prečnika 20 mm, a najduži put kroz plućni parenhim bio je 50 mm.

Na osnovu naših rezultata možemo zaključiti da je transtorakalna biopsija vođena CT-om i tehnikom CORE biopsije minimalno invazivna, jeftina procedura, sa visokom stopom dijagnostičke tačnosti i prihvatljivo niskom stopom komplikacija, te je stoga jedan od obaveznih koraka koji treba razmotriti u dijagnostici torakalnih masa.

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**Ključne reči:** *biopsija, perkutana, transtorakalna, kompjuterizovana tomografija (CT), pneumotoraks*