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ACCURACY OF PERCUTANEOUS CT-GUIDED LUNG BIOPSY IN ACHIEVING GOOD TISSUE SAMPLING AND ASSESSING THE COMPLICATIONS RATES

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ABSTRACT

Introduction: Percutaneous computed tomography-guided biopsy (PCTGB) is a safe, and simple technique for the taking biopsy from lung lesions and performing quick and reliable diagnosis. It is important to know the perfect procedure method and complications rates and its related causes to perform the procedure. **Objective:** To explain the perfect procedure of tissue sampling to avoid the risk of alternative risky options as thoracotomy and effect of its related anesthesia and to be aware of associated complications that may happen during the procedure and their relation with the characteristics of the patients, the types of lesions and the approach used in our institution. **Materials and Methods:** It is a retrospective study of 64 patients that perform (PCTGB) between May 2023 and April 2024 in the Radiology department of the in the Medical city center in Baghdad / Iraq. **Results:** Of the 64 patients, there was 17 patients (26.5%) presented with complications of which pneumothorax was the most common (20.3%), followed by two focal intra-parenchymal hemorrhage (3.1%) and 2 hemoptysis (3.1%). Patients with pulmonary comorbidities, especially emphysema, with small lesions, without adherence to the pleura with greater needle tract, had a higher rate of complications. **Conclusions:** The PCTGB is a simple and safe procedure, having low rate of complications, even if complications occur, majority of them are simple, just requiring patient reassurance and short term follow up, the most common being pneumothorax, alveolar hemorrhage and hemoptysis.

KEYWORDS: Complications, Lung Biopsy, Percutaneous CT-Guided, Tissue Sampling.

INTRODUCTION

Lung cancer is one of the leading causes of cancer deaths, accounting for 26-30 % of deaths worldwide[1], and this requiring new and minimally invasive procedures for correct histological tying and follow up of these lung lesions with low risks of complications as much as possible. PCTGB considered to be a relatively simple and safe procedure and being reliable technique for the diagnosis of pulmonary mass lesions.[2-7] PCTGB is one of the procedures that recently being progressively used because of its minimally invasive characters compared to open biopsy that may number of disadvantages. The PCTGB involves removing a core of tissue with dimensions of about 2 mm thickness and length of 10-20 mm from a lung mass or pathological tissue using a specific needle under the guide of the CT scan. Computed tomography (CT)-guided cutting needle biopsy is an effective diagnostic method for lung masses or nodules with high diagnostic accuracy.[8]

Core biopsy not only distinguishes between benign and malignant lesions but also helps in tumor typing of lung cancer, so rapid initiation of specific therapy (chemotherapy or surgery) is possible depending on results of PCTGB and imaging bases.

PATIENTS AND METHODS

This study was conducted in the Medical city center in Baghdad in the period from May 2023 to April 2024, the data were collected from a total of 64 patients with their ages between (17-82) years, these patients were referred to the interventional radiology unit from different departments (e.g., chest, medicine, and oncology) after discovery of lung or mediastinal mass lesion. Those (64 patients) underwent PCTGB of lung lesions with inclusion criteria as follows:

(a) Patients that already having lung tumors to confirm diagnosis before starting specific therapy (e.g chemo-radiotherapy) and/or follow up during or after treatment.
(b) Patients with pulmonary metastasis.

(c) Pulmonary mass lesions with unknown final diagnosis.
(d) Patients with mediastinal masses and pulmonary lymph nodes.

Whole patients were having a chest enhanced CT being reviewed and the access site was determined according to location of the tumor.

Before starting each procedure, for each patient, laboratory investigations done including a complete blood count, virology screening, and blood coagulation screen tests (platelets count where it should be > 50, 000 at least, INR < 1.5), if the patient was on antiplatelet or anticoagulant (e.g. if patient on aspirin or clopidegrol) had their treatment should stopped for 5 days.

The imaging modality that used in our study was CT scan machine type Siemens (Somatom definition AS) of 64 slice with slice thickness of 1 mm, using low KV technique (120 KV and 100 mAs). Mediastinal soft tissue window axial views were used for visualization of the lung lesion and selecting a needle tract during procedure whereas pulmonary window axial views were taken at the end of procedure for detection of presence of pneumothorax as it is the most common complication.

The core biopsy was taken by the coaxial technique method (this method makes it possible to acquire several samples in a single puncture); in this method the instrument is the Co-axial introducer needle, that having a combination of an outer needle introduced instrument of 18 gauge x 20 cm length and inner introducer needle 17 gauge x 14.9 cm.

Based on the CT findings, the lesions size ranged from 13-100 mm in diameter. Out of 64 patients, 29 had a right side lung lesions, while left side lung mass was reported in 23 cases, bilateral lung lesions was observed in 12 cases, and three patient was reported as mediastinal tumor. an informed consent for the patients and his relatives regarding the normal possible risks that may occur during the procedure (e.g the pneumothorax). After the patient agreement and evaluating risks and benefits, the procedure was done.

Procedure

CT-guided core biopsy procedure of lung mass lesions was performed as an inpatient in the intervalsional department. An experienced radiologist was also present during the procedure to support us in CT unit. The patient's appropriate position was done (supine, prone, or lateral) according to the location of the lesion. The localization of site of needle puncture on patient skin, angle of the entry of the needle, route of the needle, and the distance between the skin and lesion was done by CT scan. The skin surface was cleaned with povidone iodine, local anesthesia was given using 5-10 ml of lidocain 1-2%, and then, Tru-cut biopsy needle was introduced through determined focus on skin. Following advancement of the needle, sequential CT scan slice was taken to till the tip of the needle reaching the mass. The biopsy sample was obtained from the lesion in form of thread like tissue of 1-2 mm thickness and 10-20 mm length, about three to five trials was done and the tissue was kept in test tube containing 10% formalin solution and sent to the histopathology department. Patients were kept after that in the recovery room for 1 hour for observation and a CXR was taken 1hr after procedures and discharge if no complication was detected. In our study, pneumothorax in happened in 13 cases and only one patient with pneumothorax required chest tube after referral to cardiothoracic unit, two patients developed simple alveolar hemorrhage and two patient developing hemoptysis (one is massive and one is mild) both of these patients were having cavitating lung mass lesion, the hemoptysis recovered on short term follow up.

RESULTS

In the current study, the collected tissue samples through coaxial core needle biopsy technique form the 64 referred patients from different medical compartments, these patients were 43 male patients and 21 females, with age ranging between 17-82 years. The pulmonary mass lesions were variable in size with the size of the lesions are divided into three categories, the first category lesions measuring < 30 mm, second category lesions measuring between 30-50 mm and third category measuring > 50 mm, there were 11 pulmonary lesions measuring < 30 mm (6 of them are males and 5 of them are female patients), 16 lesions measuring 30–50 mm (11 male and 5 female patients), and 37 lesions measuring >50 mm (26 male and 11 female patients).

The smallest lesion was 13 mm, and the largest 100 mm. The mean size of the measured lesions is (61.4 mm).

Table (1): Distribution of the studied sample according to gender in relation to the size of the lesions.

Lesions	No. of lesions	Gender		p-value*
		Male	Female	
		No.(%)	No.(%)	
1st category (< 30 mm)	11	6(54.5)	5(45.5)	0.706
2nd category (30-50 mm)	16	11(68.8)	5(31.2)	
3rd category (> 50 mm)	37	26(70.3)	11(29.7)	
Total number	64	43(67.2)	21(32.8)	
**Chi square test*				

The histopathological results of the obtained samples showing that the tissues sample were having sufficient tissue for diagnosis in 58 biopsies (90.6 %) whereas 6 biopsies (9.3%) were non-diagnostic.

The histopathological results of the taken samples of the 58 sufficient tissue biopsies were malignant in 42 patient (72.4 %), (mainly lung carcinomas, adenocarcinomas and metastasis), 16 (27.5%) were being benign (mainly fibrotic and inflammatory masses).

The 6 non-diagnostic biopsies causes were classified according to the lesion size into three categories; those non-diagnostic lesions of less than 30 mm were two samples both having non-sufficient materials for diagnosis, in the 2nd category being 1 biopsy were non-diagnostic due non-sufficient sample, while at the third category there was three non-diagnostic samples (one due to necrosis and two due to insufficient materials for diagnosis). Among the 5 cases with non-diagnostic biopsy results, three proved to be malignant and one proved to be benign later on other biopsy cession, and one patient is missed.

Table (2): Distribution of the studied sample according to Tissue Sample Adequacy in relation to the size of the lesions.

Lesions	No. of lesions	Tissue Sample Adequacy		p-value*
		Adequate	Non-diagnostic	
		No.(%)	No.(%)	
1st category (< 30 mm)	11	9 (81.8)	2 (18.2)	0.598
2nd category (30-50 mm)	16	15 (93.8)	1 (6.2)	
3rd category (> 50 mm)	37	34 (91.9)	3 (8.1)	
Total number	64	58(90.6)	6(9.4)	
**Chi square test*				

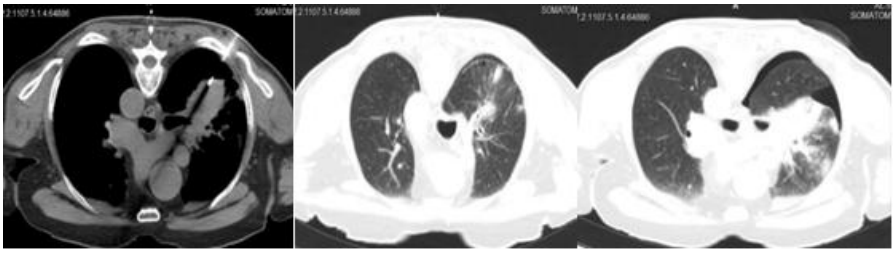
The diagnostic accuracy of overall in the current study was (96.9%), with (96.5%) sensitivity, (99.4%) specificity, (99.9%) PPV, and (57.3%) NPV. The values of sensitivity, specificity, PPV, and NPV according to the lesion size are given in form of table. Out of 58 biopsies, 53(91.4%) were true positive, 2(3.4%) were true negative and 3(5.2%) false negative. The false positive result was not found in the present study.

Sensitivity is lowest in the third category with lesions >50 mm, (due to false negative biopsy results in 3 patients). Diagnostic accuracy was 100.0% in lesions <30 mm, with no true negative and false negative results.

Table (3): The relation of the of lesion size on diagnostic accuracy, sensitivity, specificity, positive predictive value and negative predictive values.

Lesion size	Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
1st category (< 30 mm)	100.0	------	99.3.0	------	100.0
2nd category (30-50 mm)	96.5	98.0	99.7	97.0	98.8
3rd category (> 50 mm)	94.1	100.0	100.0	49.5	94.2
Total	96.5	99.4	99.9	57.3	96.9

Complications during biopsy procedure happened in 17 patients (complications rate 26.5 %). The most common complication was noted in our study was pneumothorax where it developed in 13 patient (with a rate 20.3 %) three of these patients having interstitial lung disease. Majority of pneumothoraxes where minor in degree and only one patient requiring chest tube placement and considered the only one major complication (rate of 1.5%). There are two patient developing parenchymal hemorrhage (3.1%) and two patents developing hymoptysis (3.1%) as a complication (rate of 4.6 %).



(a) **(b)** **(c)**

(a) mediastinal window shows that the tip of the biopsy needle within the center of the left lung mass (at superior segment of left lower lobe).
(b) Axial CT pulmonary window of the same patient shows evidence of parasetal emphysema on the anterior sub-pleural margin of left lung.
(c) pneumothorax on post biopsy procedure.

There was no significant difference in complication rates with regard to sex or age of the patient, position of the patient, operators while the interstitial lung diseases (Emphysema) was considered as a risk factor for the occurrence of pneumothorax in our study, so there are three factors that affecting the occurrence of complications, lesion size and depth within the lung and the presence of underlying interstitial lung disease.

The highest complication rate was 7(63.6%) in lesions <30 mm. The lowest complication rate 2(5.4%) was in lesions >50 mm.

The location of pulmonary lesions and its related complications was also classified in our study at central (deep lesions) and peripheral (superficial) lesions according to distance from pleural surface.

Regarding the relation of lesions depth (distance from pleura) in relation to complications (pneumothorax), there was 13 cases developing pneumothorax during biopsy procedure, 7 cases of the lesions associated with pneumothorax related to first category that measuring < 30 mm (five lesions are located centrally and two lesions of superficially located). There was 4 cases of pneumothorax associated with lesions related to second category that measuring 30-50 mm (3 lesions are located centrally and one lesion located peripherally) and 2 cases of pneumothorax of the lesions related to third category that measuring >50 mm (both located centrally), so the depth of the lesions within the lung is also statistically not significant (p = 1.000).

Table (4): The relation of tumor location effect to the percentage of pneumothorax complications.

Lesions	No. of lesions	No. of lesions with complications	Depth of the lesion		p-value*
			Superficial	Deep	
			No.(%)	No.(%)	
1st category (< 30 mm)	11	7(63.6)	2(28.6)	5(71.4)	1.000
2nd category (30-50 mm)	16	4(25.0)	1(25.0)	3(75.0)	
3rd category (> 50 mm)	37	2(5.4)	0(0.0)	2(100.0)	
Total number	64	13(20.3)	3(23.1)	10(76.9)	
*Chi square test					

DISCUSSION

In the current study, the estimated diagnostic accuracy was (96.6%), the sensitivity (96.5%), the specificity (99.4%), the PPV (99.9%), the NPV (57.3%) in addition to estimation of the complication rates that happen during the CT-guided coaxial core biopsy in in a three categories classified according to lesion size (<3 mm, 30–50 mm, and >50 mm lesions).

The obtained results were compared to previous studies that assess the diagnostic accuracy of results acquired from coaxial core biopsy technique.[10, 16, 17]

Diagnostic accuracy, sensitivity and specificity were estimated for each group as follow:
1. In the 1st category lesions (that < 30 mm lesions), the estimated diagnostic accuracy, sensitivity and PPV were 100%. Some previous studies results revealing that small-sized lesions considered as a risk factor affecting the diagnostic accuracy, whereas others studies notify that lesions ≥2 cm demonstrating high level of diagnostic rates.[9–11, 18, 19]

The obtained in our study are comparable to some extent with the previously mentioned studies as we had 9 lesions ≤ 2 cm.

2. for the 1st category lesions (lesions measuring 30-50 mm) the diagnostic accuracy 98.0%, the sensitivity 95.74% and specificity 100%.

3. regarding the third category group lesions (lesions>50 mm) the estimated results of diagnostic accuracy, sensitivity and specificity were 93.9%, 93.65%, and 100% respectively.

In the last two categories, we had 4 false negative results (6.2 %), the false results were due to peri-lesional inflammatory changes that encircling the tumor lesions, the effect of sample taken from necrotic area and occasionally technical difficulties in obtaining tissue in small central lesions.

To delineate the vital tissue from necrotic tissue/peri-lesional inflammatory change of large tumors mainly, in the pre-procedural biopsy our planning was to perform native and contrast-enhanced scans where the vital tissue are enhancing and the enhancing vital tissue were the target of the biopsy to avoid the incorrect results. Yeow *et al.*,[10] report lesions >50 mm, and Hiraki *et al.*,[11] lesions ≥31 mm as an independent factor for diagnostic failure.

Regarding the 6 cases (9.3 %) with insufficient materials for histopatholigical studies, there was only 2-3 biopsies where taken/lesion to avoid occurrence of pneumothorax

as a main complication; however, the samples were not sufficient for performing accurate histopathological results and the patient return again for resampling biopsies, and obtaining 4-5 samples for each lesion and this increase in number of samples to more than 3 allows to obtain better results later (4 patients out of 5 giving good histopathological results) and therefore there should be optimally at least 4-5 samples should take form a lesion to perform higher level of diagnostic accuracy and diminishing patient risks of complications at same time, that which is our study done, where in our study, less than 3 samples/lesion were taken in 5 patients to avoid pneumothorax that may occurred during the procedure; but samples were insufficient for histopathologic diagnosis, after resampling the same lesions for 3-5 samples, the specific diagnosis in histopathlogy was improved, where the diagnosis was confirmed to be malignant in 3 patients and one patient confirmed to have benign inflammatory lesion, while the 5th patient is missed.

The histopathological results of the biopsies were malignant in 42 biopsies (65.6 %) including:
a. Primary lung carcinoma and adenocarcimoa subtypes in 19 cases (29.6 %)
b. Secondary metastasis were specified in 23 case (35.9%)

Benign histopathological results were 16 case (25%) including inflammatory masses and fibrotic masses.

The current results were in accordance with data published by Wehrshuetz *et al.*,.[21]

Non-small cell lung carcinoma (NSCLC) was the dominant type of lung carcinoma, and adenocarcinoma was the leading subtype, which is to be expected since adenocarcinomas are the leading group of primary lung cancers and most often peripherally located.[20]

The overall complication rate in the current study was 26.5%, and pneumothorax was the most frequent complication. The second other complication that occurred was a minor intrapulmonary hemorrhage that has been occurred in two patients and hemoptysis occurred in two patients. The assessment for the occurrence of procedural complications in correlation with other parameters including patient's age, sex, underlying emphysema, lesion size, depth of the lesion, and position of the patient during the procedure; however, previous study results of the chi-square and Mann Whitney U tests, which was also reported by some other studies[21, 22], revealing that the size of the lesion and the lesion depth (distance from the lesion to the pleura) where considered a the most important significant risk factors for development of the complications.

Just one complication in the present study was documented to be a major complication is noted and it was a pneumothorax that need drainage, occurred in 1 patient (1.5%). Also the incidence of complications where lower than other studies when we use 18G needle biopsy where used in other studies.

Also, it was found that the incidence of complication rates were lower in comparison with some other studies in which 18G core biopsy needle was also used.[9, 21, 23]

The patient with the major pneumothorax was referred to cardiothoracic unit after chest tube was inserted.

The patient that developed major pneumothorax was having mild form of paraseptal emphysema and there was two other patient having some form of emphysema developed minor form of empyema during the procedure, so emphysema considered as independent risk factor for occurrence of complications. Laurent *et al.*,[22] reported emphysema as independent factors for higher percentage of pneumothorax requiring drainage, and Takeshita *et al.*,[9], consider that supine position during procedure to be as a risk factor for major pneumothorax.

There are three patient developing mild intraparenchymal hemorrhage as a second complication (rate of 4.6 %), which is minor complication, it was self-limiting just requiring patient reassurance. Intrapumonary hemorrhage after biopsy procedure was considered as simple complication not requiring any further medical treatment.[25]

The reported rates of hemorrhage vary from 4%–27%, and the suggested threshold for minor pneumothorax and hemorrhage resolution was 45%.[14, 26]

Risk factors for higher grade hemorrhage was reported in in previous studies are female gender, elderly patients, preexisting interstitial lung diseases (e.g emphysema), coaxial biopsy technique, lesions less than 3 cm and deeply located lesions.[27, 28] The current study showed that the minor and major complications were close to CIRSE guidelines on percutaneous needle biopsy and SIR recommendations for quality improvement threshold.[13, 14]

Limitation of our study

The number of lesions <30 mm, and especially lesions <20 mm near the hilar areas were relatively small and their biopsy procedure was difficult. A significant quantity of the current study patients was inoperable and the diagnosis of these lesions were obtained from CT scan findings and response to medical oncologic treatment.

Finally, the results of our study was as a conclusion reflect that that lesion size and depth of the lesion from the pleura are major factors that affecting the diagnostic accuracy and complication rates. For lesions >50 mm:
1. The diagnostic accuracy and NPV were lowest in lesions > 5 mm, with (96.6%) and (57.3%), respectively.

2. Peri-lesional inflammatory changes considered as main factor for diagnostic failure and false negative results.

Pre-biopsy evaluation of contrast-enhanced CT scans was highly sensitive in delineation of necrotic parts in large tumors and biopsy planning. Complication rates were higher in smaller lesions and those more distanced from the pleura, with minor pneumothorax being the most frequent complication.

CONCLUSION

- CT guided lung lesion is safe, cost-effective and much less invasive technique in comparison with other surgical options.
- The PCTGB having lower rate of procedural complications, even if complications occur , majority of these complications are simple, just requiring patient reassurance and short term follow up.
- The presence of underlying pulmonary interstitial disease is a risk factor should be considered, where it increase the incidence of complications mainly the pneumothorax.
- The intrapulmonary alveolar haemorrhage is a minor complication occur in minority of patients and require just short term follow up.
- The presence of caveating lung lesion is a risk factor for developing haemoptysis and in the same time , it increase the possibility of non-diagnostic tissue sampling.

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