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# Evaluation of thoracic diseases with computed tomography guided biopsy

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## Abstract

Computed tomography (CT) guided percutaneous procedures like the fine needle aspiration cytology (FNAC) and fine needle aspiration biopsy (FNAB) are reliable techniques for diagnosing various thoracic diseases. These modalities are used for diagnosis in suspicious lung, pleural, mediastinal and vertebral and pulmonary lesions. **The aim.** We conducted a study in a Pulmonary Medicine Department of tertiary care hospital to study the efficacy and safety of CT guided FNCA/FNAB in thoracic diseases. **Methods.** A retrospective study was conducted at a tertiary care center with Information and Ethics committee permission within a total duration of two years. The study included patients presenting with following: 1) mediastinal mass lesions, 2) pulmonary solitary pulmonary nodules/masses, 3) pulmonary cavity, cyst and consolidation of undiagnosed etiology, 4) pleural mass, nodules, loculated collections, 5) extra-pulmonary and spinal tuberculosis suspects with pre/paravertebral abscess. Procedure details, radiological images and pathological and microbiological reports were retrieved from case record book of patients available in department. **Results.** Study population consisted of 108 patients. Neoplastic diseases were 85 (78.70%) and Non- neoplastic diseases 23 (21.29%). In neoplastic diseases 78.82% patients had lung Cancer of which 85.07% non small cell carcinoma and 14.92% small cell lung cancer. Out of non small cell lung cancer adenocarcinoma of lung was the commonest. The most common non neoplastic diseases was tuberculosis. CT guided biopsy procedure was performed without any complications in 61.11%. The most common complication was pneumothorax (27.77%). The yield of CT guided biopsy was 98.14%. **Conclusion.** Percutaneous CT-guided lung biopsy is an effective, highly accurate, and safe method of obtaining tissue for the diagnosis of indeterminate pulmonary lesions especially in neoplastic diseases and tuberculosis.

**Key words:** CT guided biopsy, thoracic lesions, efficacy.

**Conflicts of interest.** There are no conflicts of interest for all authors.

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**Informed consent.** This was a retrospective Institutional Ethics Committee approved study. A consent waiver was allowed as per regulations for retrospective studies.

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# Оценка заболеваний органов грудной клетки с помощью биопсии под контролем компьютерной томографии

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## Резюме

Чрескожные процедуры под контролем компьютерной томографии (КТ), такие как тонкоигольная аспирационная цитология (*fine needle aspiration cytology* – FNAC) и тонкоигольная аспирационная биопсия (*fine needle aspiration biopsy* – FNAB), являются надежными методами диагностики различных заболеваний органов грудной клетки. Эти методы используются для диагностики поражений легких, плевры, средостения, позвоночника и легких. **Целью** исследования, проведенного в отделении пульмонологии больницы третичного уровня, явилось определение эффективности и безопасности FNCA / FNAB под контролем КТ при заболеваниях органов грудной клетки. **Материалы и методы.** Ретроспективное исследование проводилось в течение 2 лет в центре третичной медицинской помощи с разрешения Комитета по информации и этике. В исследование были включены следующие пациенты: 1) с новообразованиями средостения; 2) с легочными солитарными узлами / новообразованиями; 3) с полостями, кистами и консолидацией в легких невыясненной этиологии; 4) с плевральными новообразованиями, узелками, осумкованными скоплениями; 5) с плевральными массами, узелками, осумкованными скоплениями, подозрением на внелегочный туберкулез и туберкулез позвоночника с пре-, паравертебральным абсцессом. Данные о проведенной процедуре, рентгеновские снимки, патологоанатомические и микробиологические отчеты были получены из историй болезни, имеющихся в отделении. **Результаты.** Выборку составили 108 пациентов. Опухолевые заболевания выявлены у 85 (78,70 %), неопухолевые – у 23 (21,29 %) пациентов. У 78,82 % пациентов с опухолевыми заболеваниями выявлен рак легкого,

у 85,07 % из них – немелкоклеточный, у 14,92 % – мелкоклеточный рак легкого. У больных с немелкоклеточным раком легкого наиболее часто встречалась аденокарцинома легкого. Наиболее частым неопухолевым заболеванием являлся туберкулез. Биопсия под контролем КТ выполнена без каких-либо осложнений в 61,11 % случаев. Наиболее частым осложнением (27,77 %) был пневмоторакс. Биопсия под контролем КТ позволила установить диагноз в 98,14 % случаев. **Заключение.** Чрескожная биопсия легкого под контролем КТ является эффективным, высокоточным и безопасным методом получения ткани для диагностики неопределенных поражений легких, особенно при опухолевых заболеваниях и туберкулезе.

**Ключевые слова:** биопсия под компьютерно-томографическим контролем, торакальные поражения, эффективность.

**Конфликт интересов.** Конфликт интересов авторами не заявлен.

**Финансовый.** Спонсорская поддержка исследования отсутствовала.

**Информированное согласие.** Исследование ретроспективное, одобренное комитетом по этике учреждения. В соответствии с правилами ретроспективных исследований, получения информированного согласия у пациентов не требовалось.

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Computed tomography (CT) guided percutaneous procedures like the fine needle aspiration cytology (FNAC) and fine needle aspiration biopsy (FNAB) are reliable techniques for diagnosing various thoracic diseases. The use of CT guidance has improved the diagnostic yield and has reduced the risk of complications. FNAC with 20 – 25 G needle, first described in 1965 by Nordenstrom, provides a cytological sample of exfoliated cells [1]. Several reports have cited cytology to be less reliable in determining the cell type in malignant lesions. This drawback can be obviated through immediate on-site evaluation by a cytopathologist but limited access of same has made the use of automated cutting needles to obtain core tissue for histologic evaluation a necessity. Core biopsy with 14 – 18 G cutting needle was described first time in early 1980 and is an established mode of evaluation for benign and malignant thoracic diseases [2].

These modalities are used for diagnosis in various undiagnosed thoracic diseases like lung, pleural, mediastinal and vertebral, para/pre-vertebral lesions; pulmonary lesions inaccessible to bronchoscopy or in which bronchoscopic biopsies are non-diagnostic/contraindicated. Their utility has been reported in previous literature [3 – 5]. The case scenarios include:

- mediastinal mass lesions [6];
- pulmonary solitary pulmonary nodules/masses [7];
- pulmonary cavity, cyst and consolidation of undiagnosed etiology [8];
- pleural mass, nodules, loculated collections [9];
- spinal tuberculosis with pre/paravertebral abscess [10].

CT guided procedures can cause certain complications like pneumothorax (8 – 64%) which is most common followed by bleeding (2 – 10%) and local hematoma formation, hemoptysis, parenchymal hemorrhage, subcutaneous emphysema, and rarely air embolism vasovagal syndrome and tumor seeding. Poor respiratory functions, oncooperative patient, lack of safe access and uncontrollable bleeding diathesis are contraindications of CT guided procedures. The most significant risk factors affecting pneumothorax are lesion size, depth and experience of the radiologist. Risk factors impacting bleeding complications were lesion size, lesion depth and absence of pleural effusions. These are manageable in most and considering the benefit of achieving the accurate diagnosis in evaluation of undiagnosed lesions CT guided procedures are an important part of the diagnostic algorithm. We describe the efficacy and safety of computed tomography guided fine needle aspiration cytology/fine needle aspiration biopsy in evaluation of various thoracic diseases.

**Aims and objectives.** We conducted a study in a Pulmonary Medicine Department of tertiary care hospital to study the efficacy and safety of CT guided FNCA/FNAB in thoracic diseases.

## Materials and methods

A retrospective study was conducted at a tertiary care center with IEC (information and ethics committee) permission. The study included patients referred to the pulmonary medicine department with the following:

- mediastinal mass lesions;
- pulmonary solitary pulmonary nodules/masses;
- pulmonary cavity, cyst and consolidation of undiagnosed etiology;
- pleural mass, nodules, loculated collections;
- extra-pulmonary and spinal tuberculosis suspects with pre/paravertebral abscess.

This study patients had undergone CT guided FNAC/FNAB for various thoracic diseases over 2 year period. Case record sheets were reviewed for clinical history and examination details. Procedure details, radiological images and pathological and microbiological reports were retrieved from case record book of patients available in the department of pulmonary medicine in at a tertiary care center.

The patients preparation and basic investigation like chest X Ray, HRCT thorax, coagulation profile were as per guidelines [11]. All procedures were performed under local anaesthesia. A written consent was obtained after explaining the procedure, possible complications and risk versus benefits associated with the procedure. Most of the procedures were done using a coaxial technique. A quick core biopsy needle set (cook core biopsy needle or BARD Mission Disposable biopsy needle) was used. Length of the biopsy set (9, 15, and 20 cm) was taken depending upon the depth of lesion. Mostly, an 18-gauge biopsy set was used; however a 20 gauge set was used if chances of complications were more. For aspiration, Chiba needle of varying gauge and length were used depending upon the depth of lesion and nature of sample. In general 5 – 6 core specimens were

obtained by slight change of direction of outer needle so as to sample different area. If core biopsy and aspiration (for microbial cultures) were done using same outer guiding needle, core biopsy was performed first and aspirations later. The tissue sample were place in formalin for histopathology and IHC if required in case of suspension of malignancy and normal saline for Acid fast bacilli culture and sensitivity and GeneXpert. Aspirates were directly processed for Microbial AFB culture and GeneXpert.

Diagnostic yield were analyzed for core biopsy with or without Microbial specimens, as fine needle aspiration cytology was performed in few cases. Diagnostic yield was calculated by dividing the number of procedures that resulted in diagnosis divided by total number of CT guided biopsy procedures. Complications were checked on table immediately for hemorrhage in from of hemoptysis new ground glass opacities, pneumothorax and later 6 – 8 hours after procedure the repeat check scan procedure were done to detect the late complications and progression of complications detected earlier in first check CT scan. Complications were considered as minor if they were managed conservatively and major complications if required active management like pneumothorax needing chest tube drain insertion. Results were analyzed with yield and complications. Diagnostic yield and complication rates were calculated and were compared with bronchoscopic findings if feasible. Statistical analysis was done for the qualitative data using mean and percentages. Study outcomes were:

- percentage of yield of lung, pleural diseases, mediastinal, vertebral and paravertebral intrathoracic biopsies;
- percentage of complications of lung, pleural diseases, mediastinal, vertebral and paravertebral intrathoracic biopsies;
- percentage of complications requiring intervention;
- percentage of complications managed conservatively;
- comparison of CT guided procedure with percentage of bronchoscopic findings if feasible;
- repeat procedure and their yield were noted whenever applicable.

## Results

Total 108 patients were enrolled in the study. Out of 108 patients, 89 (82.40%) were men and 19 (17.59%) were women who underwent CT guided biopsy for various thoracic diseases. The male to female ratio was M : F – 4.7 : 1. All 108 biopsies and aspirations were performed with a 64 – slice Multiple detector CT scanner (Philips medical systems). Mean age of patients was 53.88 years with mean age of male patients being 54.34 and female patients was 51.73 years. The Age distribution of patients who underwent CT guided biopsy is given in Table 1.

Lesions were situated most commonly in the lung (71/108), followed by Hilum (23/108), anterior mediastinum (5/108), middle mediastinum (5/108), posterior mediastinum including paravertebral and prevertebral lesions (4/108).Out of 108 patients 85 (78.70%) patients had neoplastic diseases and 23 (21.29%) had non-neoplastic diseases. Out of 85; 67 (78.82%) patients had lung cancer and 5 patients had lymphomas (1 – Hodgkin's lymphoma

*Table 1*
*Age distribution of all patients who underwent CT guided biopsy in thoracic disease*

*Таблица 1*
*Распределение по возрасту пациентов с заболеваниями органов грудной клетки, которым была выполнена биопсия под контролем компьютерной томографии*

| Age Group | Number of patients |
|---|---|
| 0 – 10 | 0 |
| 11 – 20 | 7 |
| 21 – 30 | 4 |
| 31 – 40 | 6 |
| 41 – 50 | 8 |
| 51 – 60 | 36 |
| 61 – 70 | 39 |
| 71 – 80 | 7 |
| 81 – 90 | 1 |
| 91 – 100 | 0 |

and 4 – non-Hodgkin's lymphoma), 1 – mature teratoma, 2 – sarcomas, 1 – spindle cell tumor, 3 – thymoma, 6 – metastasic cancer to lung (2 – follicular thyroid cancer and 2 – metastasic adenocarcinoma of breast, 1 – metastatic urothelial cancer from urinary bladder, 1 – metastatic renal cell cancer). In lung cancer 57 (85.07%) patients had non-small cell lung cancer i.e. NSCLC and 10 (14.92%) patients had small cell lung cancer. Out of NSCLC 28 (49.12%) were Adenocarcinoma, 24 (42.10%) Squamous cell carcinoma, 1 (1.75%) Large cell lung cancer, 1 (1.75%) Adenosquamous cell lung cancer, 3 (5.26%) other NSCLC. In 23 non-neoplastic diseases , on histology 12 patients had caseating granulomatous inflammation, 1 – Bronchiolitis obliterance organizing pneumonia, 1 – ILD- desquamated pneumocytes, 1 – Degenerated necrotic tissue, 1 – hydatid cyst with aspergillus colonization, 1 – non-viable lung parenchyma, 1 – hydatid cyst , 1 – pneumatic consolidation, 1 – PMF-hylanized collagenous tissue and 3 had pus aspiration. Out of 23 non-neoplastic diseases; 15 were tuberculosis (12 cases – granulomatous inflammation and 3 pus aspirates). Of these 15 TB patients; 5 (33.33% of total TB patients had MDR TB).

Biopsies from different lobes of lung, hilum and mediastinum were done. Out of 108 patients 66 (61.11%) had no complication, 30 (27.77 %) patients developed pneumothorax. Of them 19 (17.54%) developed mild Pneumothorax that was managed conservatively, however 11 (10.185%) developed major Pneumothorax that required intercostal drainage. 2 (1.85%) patients developed hemothorax, 7 (6.48%) hemoptysis, 5 (4.62%) Pulmonary alveolar hemorrhage and 1 (0.925%) developed cerebral air embolism. Out of 42 patients who developed complications; 3 patients had more than one complications, at a time like 2 patients had pulmonary alveolar hemorrhage along with mild Pneumothorax and one patient had cerebral air embolism with massive Pneumothorax. Cerebral air embolism managed with hyperbaric oxygen therapy and anticonvulsants. Complications rate was as follows: in Right UL – 38.46%, Right LL including ML – 37.5%, left UL – 15.78%, left

***Table 2***
***Biopsies from different lobes of lung, hilum and mediastinum were done and their complications; n (%)***
***Таблица 2***
***Выполненные биопсии из разных долей легкого, ворот легкого и средостения и их осложнения; n (%)***

| Complications of CT guided FNAC/FNAB in Thoracic disease | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Complications | RUL | RML | RLL | LUL | LLL | Right Hilar | Left hilar | Anterior mediastinal | Middle mediastinum | Posterior mediastinum | Total |
| Total No. of biopsy | 26 | 3 | 13 | 19 | 10 | 15 | 8 | 5 | 5 | 4 | 108 |
| No complications | 16 (61.5) | 0 | 10 (76.92) | 16 (85.89) | 5 (50) | 8 (53.33) | 1 (12.5) | 5 (100) | 3 (60) | 2 (50) | 66 (61.11) |
| Mild pneumothorax | 4 (15.8) | 1 (33.33) | 2 (15.38) | 1 (5.26) | 2 (20) | 2 (13.33) | 4 (50) | 0 | 2 (40) | 1 (25) | 19 (17.54) |
| Major pneumothorax | 4 (15.8) | 0 | 1 (7.69) | 1 (5.26) | 2 (20) | 2 (13.33) | 1 (12.5) | 0 | 0 | 0 | 11 (10.185) |
| Aleolar hemorrhage | 2 (7.69) | 1 (33.33) | 0 | 1 (5.26) | 0 | 0 | 0 | 0 | 0 | 1 (25) | 5 (4.62) |
| Hemoptysis | 0 | 1 (33.33) | 0 | 0 | 1 (10) | 3 (20) | 2 (25) | 0 | 0 | 0 | 7 (6.48) |
| Others | 0 | 0 | 0 | 0 | 0 | 2 (13.33) hemothorax | 1 air embolism | 0 | 0 | 0 | 1 (0.925) embolism + 2 (1.85) hemothorax |

LL – 50%, right hilar – 46.66%, left hilar – 87.5%, mediastinal biopsy including anterior, middle and posterior – 28.57%. Complications were higher in hilar and lower lobe lesions biopsies. Pneumothorax developed in Right UL biopsy in 30.76%, right LL – 23.07%, left UL – 10.52%, left LL – 40%, Right ML – 33.33%, hilar 39.1%, mediastinal – 21.42%. Their complications are mentioned in Table 2 and figure.

Yield of CT guided biopsy procedures were – 98.14% (106/108 Patients diagnosis were achieved), however in 1 patient histopathology was suggesting Degenerative necrotic tissue and 1 patient was suggesting Non-viable lung parenchyma considered nondiagnostic; in such inconclusive histopathological reports, ambiguity over the diagnosis could be cleared with clinical evaluation and radiological correlation and further follow up.

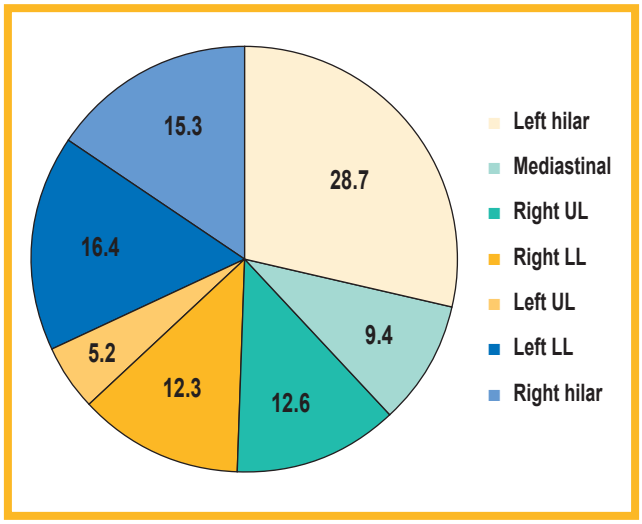


Figure. Complication rate depending on the site of biopsy; %
Рисунок. Частота осложнений в зависимости от места биопсии; %

## Discussion

A retrospective observational study was conducted with aim of to obtain efficacy and safety of computed tomography guided percutaneous biopsy of thoracic diseases. Lesions targeted were lung parenchymal lesion like mass lesions, pulmonary cavity, consolidation, cysts; mediastinal lesion; prevertebral and paravertebral lesions.

In present study total 108 patients underwent CT guided biopsy procedures which had male predominance with mean age of patients was 53.88 years. Our yield of CT guided biopsy was 98.14% which was concordant with the reported yield by other study as 93% [12]. The most common lesion obtained on CT guided biopsy procedure was Lung cancer (78.8%), out of which most common type was Non-small cell lung cancer (85.1%), and small cell carcinoma was (14.9%), which is consistent with other studies and international data in which NSCLC, which accounts for the remaining 85% of cases, is further divided into three major pathologic subtypes: adenocarcinoma, squamous cell carcinoma, and large cell carcinoma. Adenocarcinoma by itself accounts for 38.5% of all lung cancer cases, with squamous cell carcinoma accounting for 20%, and large cell carcinoma accounting for 2.9% [13].

In non-neoplastic lesions most common lesion was tuberculosis; however rare causes like hydatid cysts with aspergilloma, bronchiolitis obliterans organizing pneumonia, interstitial lung disease were also obtained. Tuberculosis, still being missed largely by healthcare systems every year and causing the continuing burden of multidrug resistant TB (MDR-TB), is an highly curable disease. Delay in diagnosis play a major role in increasing the infectious nature


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of the disease. Faster and more sensitive diagnostic tools will be essential for challenging thoracic lesions to rule out tuberculosis in the high TB burden countries [14]. In present study, of 108 patients 15 were tuberculosis (12 caseating granulomatous inflammation and 3 puss aspirates) of them 15 TB patients 5 (33.33%) of total TB patients had MDR TB.

Most common complication in present study was Pneumothorax (27.77%) out of which 17.54% pneumothoraxes were managed conservatively and 10.18% pneumothorax managed with intercostal drain. Pneumothorax rate varies widely according to institution, and estimate from 5 – 50% have been reported. Most post procedural pneumothoraces are small and not clinically significant; however, in up to 5 to 10% of patients, a large or symptomatic Pneumothorax requires chest tube placement [15]. Pneumothorax are more in Chronic obstructive pulmonary disease [16]. Risk of pneumothorax increases with increased number of pleural puncture [17]. Careful planning is necessary to traverse the least amount of aerated lung without puncturing bullae or pneumatocele if possible. Other complications in present study were pulmonary alveolar hemorrhage (4.62%), hemoptysis (6.48%), hemothorax (1.85%) and cerebral air embolism (0.925%). In other studies Pulmonary hemorrhage was the second most common complication of needle biopsy of the chest, with reported frequencies ranging from 4% to 27% [18, 19]. Hemothorax was exceedingly rare, with an incidence of 0.092% in one study [20]. The reported overall rate of pulmonary hemorrhage after CNB and FNA was 18% and 6.4%, respectively, with hemoptysis in 4.1 and 1.7% [21]. Small lesion size and greater lesion depth or long biopsy path are associated with a higher risk of bleeding [18, 19]. Hemorrhage was also related to CT evidence of emphysema, perhaps because of the lack of effective tamponade by adjacent tissue [22]. Patients with pulmonary arterial hypertension were at higher risk for hemorrhage [23]. Air embolism was rare but potentially fatal complication of percutaneous needle biopsy of the lung. In a large series of 9 783 biopsies, there were only 6 (0.061%) cases of air embolism [24]. Several cases have been reported in the literature [25], we observed one case of air embolism. Air embolism usually manifests as fatal arrhythmias and circulatory collapse if the air enters the coronary arteries and results in coronary ischemia. Cerebral air embolism can lead to generalized seizures and neurologic deficits [25 – 26]. If air embolism is recognized in the left heart or aorta during the procedure or is clinically suspected, the patient should be placed in the mild Trendelenburg position to prevent embolization of the air into the cerebral circulation; 100% oxygen should be administered immediately, which promotes the exchange of oxygen for nitrogen within the air bubbles and accelerates their resorption. Early hyperbaric oxygen therapy is recommended for cerebral air embolism. Supportive therapy with an anticonvulsant medication or steroids may be administered as indicated for cerebral air embolism [22 – 26]. There is also experimental evidence to suggest that cerebral edema is decreased by hyperbaric oxygen due to vasoconstriction caused by hyperoxia. Reduction of increased intracranial pressure in severe cerebral ischemia secondary to air embolism may be an added benefit of hyperbaric oxygen therapy [27].

## Conclusion

Percutaneous CT-guided lung biopsy is an effective, highly accurate, and safe method of obtaining tissue for the diagnosis of indeterminate pulmonary lesions especially in neoplastic diseases and tuberculosis. Appropriate preprocedural planning, patient preparation, and adherence to strict procedural routine can minimize the risks associated with lung biopsy. This approach is an ideal approach for pulmonary lesions inaccessible to bronchoscopy or in which bronchoscopic biopsies are non-diagnostic/contraindicated. However, it is important to counsel patients appropriately in advance of the procedure regarding their individual procedural risk of complications such as pneumothorax and pulmonary hemorrhage with regard to their lesion, presence or absence of underlying lung disease, and local expertise. The spectrum of thoracic diseases like ILD and diffuse parenchymal lung diseases are excluded from this assessment method.

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