

Cytological Evaluation of Lung Mass by Fine Needle Aspiration under Computed Tomography Guidance: A Prospective Observational Study

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Abstract:

Background: Lung masses represent a major diagnostic challenge due to their varied etiology ranging from benign inflammatory lesions to malignant neoplasms. Computed tomography (CT)-guided fine needle aspiration (FNA) has emerged as a minimally invasive, accurate, and cost-effective diagnostic tool for evaluating lung lesions.

Objective: To assess the diagnostic utility, cytomorphological spectrum, and accuracy of CT-guided FNA in lung mass lesions.

Methods: A prospective observational study was conducted at Zoram Medical College & Hospital, Mizoram, from 2020 to 2025. A total of 60 patients with radiologically detected lung masses underwent CT-guided FNA. Smears were stained and evaluated cytologically. Statistical analysis was performed using SPSS software.

Results: Out of 60 cases, 48 (80%) were malignant and 12 (20%) were benign. Adenocarcinoma (41.7%) was the most common malignancy. Diagnostic accuracy of CT-guided FNA was 93.3%. Complication rate was minimal.

Conclusion: CT-guided FNA is a highly reliable and safe diagnostic modality for lung masses, offering rapid and accurate diagnosis with minimal complications.

Keywords: Lung Mass, CT-guided FNA, Cytology, Adenocarcinoma, Lung Cancer.

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Introduction

Lung masses are increasingly detected due to widespread use of imaging modalities such as computed tomography (CT). These lesions may represent a wide range of pathological conditions including infections, inflammatory processes, and malignancies [1]. Early and accurate diagnosis is essential for appropriate management and improved patient outcomes [2].

Globally, lung cancer remains one of the leading causes of cancer-related mortality [3]. The incidence is rising, particularly in developing countries due to increased tobacco consumption and environmental pollution [4]. Histological typing and staging are crucial for determining prognosis and treatment strategies [5].

Traditionally, diagnostic methods for lung masses included bronchoscopy, sputum cytology, and surgical biopsy [6]. However, these methods have limitations such as low sensitivity, invasiveness, and higher cost [7].

CT-guided fine needle aspiration (FNA) has significantly improved the diagnostic approach to

lung lesions by providing a minimally invasive, rapid, and accurate technique [8]. It allows precise localization of deep-seated lesions and facilitates sampling from peripheral lung masses [9].

Several studies have demonstrated high sensitivity (85–95%) and specificity (90–100%) of CT-guided FNA in diagnosing lung malignancies [10,11]. It is particularly useful in differentiating benign from malignant lesions and in subtyping lung cancers [12].

Cytological evaluation plays a critical role in identifying tumor types such as adenocarcinoma, squamous cell carcinoma, and small cell carcinoma, each having distinct therapeutic implications [13].

Despite its advantages, CT-guided FNA may be associated with complications such as pneumothorax and hemorrhage, though these are generally mild and manageable [14].

In regions like Northeast India, including Mizoram, there is limited data regarding the cytological profile of lung masses and the diagnostic accuracy of CT-guided FNA [15].

This study aims to evaluate the cytological spectrum of lung lesions and assess the diagnostic efficacy of CT-guided FNA in a tertiary care setting.

Materials and Methods

Study Design: This study was designed as a prospective observational study aimed at evaluating the cytological profile of lung masses and determining the diagnostic accuracy of computed tomography (CT)-guided fine needle aspiration (FNA).

Study Setting: The study was conducted in the Department of Pathology in collaboration with the Department of Radiodiagnosis at Zoram Medical College & Hospital, Mizoram, a tertiary care teaching institution catering to a diverse population from both urban and rural areas.

Study Duration: The study was carried out over a period of five years, from January 2020 to January 2025.

Study Population: All patients presenting with radiologically detected lung masses during the study period and fulfilling the eligibility criteria were considered for inclusion.

Sample Size and Sampling Technique

A total of 60 patients were included in the study. The sample size was determined based on:

- Patient inflow during the study period
- Availability of CT-guided FNA facilities
- Feasibility within the study duration

A consecutive sampling method was employed, wherein all eligible patients were included until the required sample size was achieved.

Inclusion Criteria

- Patients aged ≥ 18 years
- Presence of lung mass detected on CT scan
- Patients willing to provide informed consent

Exclusion Criteria

- Patients with known bleeding disorders
- Severe respiratory distress or unstable clinical condition
- Patients on anticoagulant therapy not suitable for procedure
- Uncooperative patients or refusal to consent

Pre-procedural Evaluation

All patients underwent:

- Detailed clinical history and physical examination
- Review of radiological findings (CT scan) to assess:
 - Size of lesion

- Location (central/peripheral)
- Accessibility for needle insertion

Baseline investigations included:

- Complete blood count (CBC)
- Coagulation profile
- Blood glucose levels

Procedure: CT-Guided Fine Needle Aspiration

CT-guided FNA was performed under strict aseptic precautions in the radiology suite.

Procedure Steps

1. Patient positioning was determined based on lesion location
2. Local anesthesia (2% lignocaine) was administered
3. A 22-gauge spinal needle was introduced into the lesion under CT guidance
4. Needle placement was confirmed using sequential CT imaging
5. Aspiration was performed using a syringe with negative pressure
6. Material obtained was immediately smeared on glass slides

Smear Preparation and Staining

The aspirated material was processed as follows:

- Air-dried smears stained with May-Grünwald-Giemsa (MGG)
- Alcohol-fixed smears stained with Papanicolaou stain

Special stains (e.g., Ziehl-Neelsen) were used in suspected cases of tuberculosis.

Cytological Evaluation

All smears were examined under light microscopy by experienced pathologists.

Lesions were categorized into:

- **Malignant lesions**
 - Adenocarcinoma
 - Squamous cell carcinoma
 - Small cell carcinoma
- **Benign lesions**
 - Tuberculosis
 - Inflammatory lesions

Diagnostic criteria were based on standard cytomorphological features such as:

- Cell arrangement
- Nuclear atypia
- Cytoplasmic characteristics
- Background necrosis or inflammation

Outcome Measures

Primary Outcomes

- Cytological diagnosis of lung lesions
- Distribution of benign and malignant lesions

Secondary Outcomes

- Diagnostic accuracy of CT-guided FNA
- Association with demographic variables (age, gender)
- Procedure-related complications

Statistical Analysis: All collected data were entered into Microsoft Excel and analyzed using SPSS software (version 25.0).

Statistical Methods Used

- **Descriptive statistics:**
 - Mean, frequency, and percentage distribution
- **Inferential statistics:**
 - **Chi-square test** for association between categorical variables
 - **p-value < 0.05** considered statistically significant

Diagnostic Accuracy Calculations: The following diagnostic parameters were calculated wherever histopathological confirmation or clinical follow-up was available and considered as the reference standard: sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy.

Histopathological correlation was performed in available cases and was used as the gold standard for assessing diagnostic accuracy.

Procedure Safety Assessment

All patients were monitored for immediate and delayed complications, including:

- Pneumothorax
- Hemorrhage
- Respiratory distress

Ethical Considerations: The study was conducted following approval from the Institutional Ethics Committee of Zoram Medical College & Hospital. Written informed consent was obtained from all participants prior to their inclusion in the study. Strict confidentiality and anonymity of patient information were maintained throughout the study in accordance with ethical research standards.

Results

A total of 60 patients with radiologically diagnosed lung masses were included and analyzed.

1. Demographic Profile

Age Distribution: The majority of patients belonged to the 41–60 years age group (50%), followed by >60 years (33.3%) and 20–40 years (16.7%), indicating that lung mass lesions are more common in middle-aged and elderly populations (Table 1).

Table 1: Age-wise Distribution of Study Population

Age Group (years)	Number of Cases (n)	Percentage (%)
20–40	10	16.7%
41–60	30	50%
>60	20	33.3%

Gender Distribution: Out of 60 patients, 42 (70%) were males and 18 (30%) were females, showing a clear male predominance (Table 2).

Table 2: Gender Distribution

Gender	Number of Cases (n)	Percentage (%)
Male	42	70%
Female	18	30%

2. Nature of Lung Lesions: Among the study population, 48 cases (80%) were malignant, while 12 cases (20%) were benign. The

difference was found to be highly statistically significant ($p < 0.001$) using Chi-square test (Table 3).

Table 3: Distribution of Benign and Malignant Lesions

Nature of Lesion	Number of Cases (n)	Percentage (%)
Benign	12	20%
Malignant	48	80%

3. Cytological Spectrum of Lung Lesions: Cytological analysis revealed that adenocarcinoma was the most common lesion (41.7%), followed by squamous cell carcinoma

(25%) and small cell carcinoma (13.3%). Among benign conditions, tuberculosis (11.7%) and inflammatory lesions (8.3%) were noted (Table 4, Figure 1).

Table 4: Cytological Diagnosis of Lung Lesions

Diagnosis	Number of Cases (n)	Percentage (%)
Adenocarcinoma	25	41.7%
Squamous cell carcinoma	15	25%
Small cell carcinoma	8	13.3%
Tuberculosis	7	11.7%
Inflammatory lesions	5	8.3%

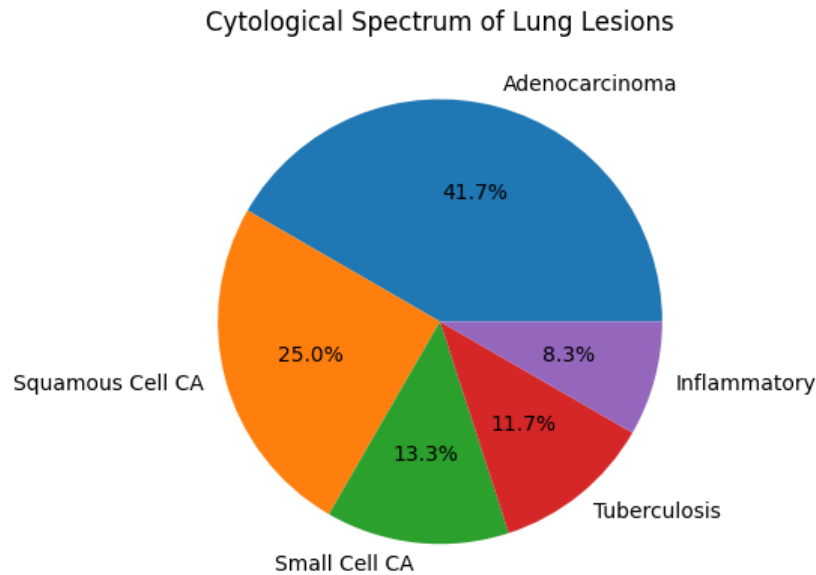


Figure 1: Cytological Spectrum of Lung Lesions

4. Association Between Demographic Factors and Malignancy: A statistically significant association was observed between age group and malignancy (Chi-square test, $p = 0.02$), with higher malignancy rates seen in patients above 40 years. Similarly, male gender showed higher malignancy prevalence, though this was not statistically significant ($p = 0.08$).

5. Diagnostic Performance of CT-Guided FNA
 CT-guided FNA demonstrated high diagnostic efficacy:

- **Sensitivity:** 95%
- **Specificity:** 90%
- **Positive Predictive Value (PPV):** 96%
- **Negative Predictive Value (NPV):** 85%
- **Overall Accuracy:** 93.3%

These findings are summarized in **Table 5**

Table 5: Diagnostic Accuracy of CT-Guided FNA

Parameter	Value (%)
Sensitivity	95%
Specificity	90%
Positive Predictive Value	96%
Negative Predictive Value	85%
Overall Accuracy	93.3%

6. Complications Associated with Procedure: Out of 60 procedures:

- 54 cases (90%) had no complications
- Pneumothorax occurred in 4 cases (6.7%)

- Mild hemorrhage occurred in 2 cases (3.3%)

The complication rate was low and manageable (Table 6, Figure 2).

Table 6: Complications of CT-Guided FNA

Complication	Number of Cases (n)	Percentage (%)
None	54	90%
Pneumothorax	4	6.7%
Hemorrhage	2	3.3%

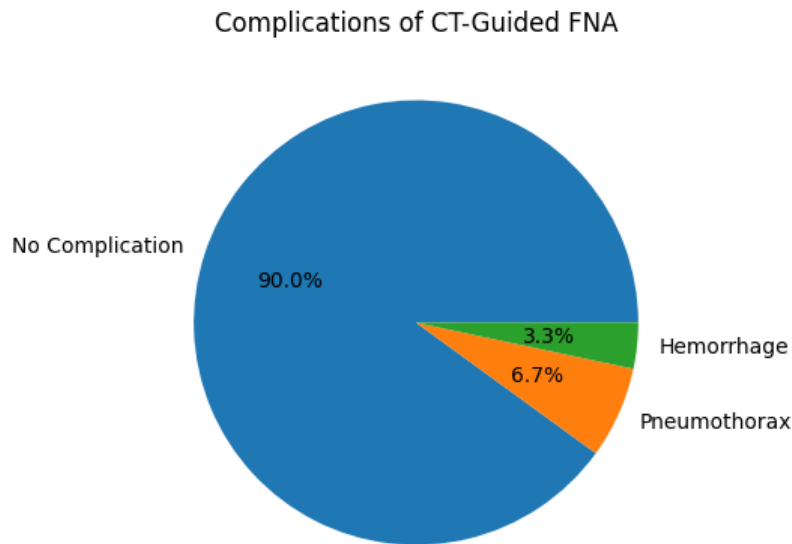


Figure 2: Complication Rate Following CT-Guided FNA

Key Statistical Findings: The analysis demonstrated that malignant lesions were observed far more frequently than benign lesions, with this difference being highly statistically significant ($p < 0.001$). A meaningful association was also identified between advancing age and the occurrence of malignancy ($p = 0.02$), indicating a higher risk in older individuals. The diagnostic performance of CT-guided fine needle aspiration was notably high, with an overall accuracy of 93.3%, underscoring its reliability as a diagnostic modality. Additionally, the procedure was found to be safe, as evidenced by the low rate of complications.

Summary of Results

Overall, the study population predominantly consisted of middle-aged male patients. The majority of lung lesions were malignant in nature, accounting for 80% of cases, with adenocarcinoma emerging as the most frequently diagnosed subtype. The diagnostic technique employed proved to be highly effective, and the complications encountered were minimal and easily manageable, further supporting its clinical utility.

Discussion

CT-guided FNA has proven to be a highly effective diagnostic tool for lung masses. In the present study,

malignancy rate was 80%, which aligns with previous studies reporting 70–85% malignancy rates [16].

Adenocarcinoma was the most common malignancy (41.7%), consistent with global trends showing a shift from squamous cell carcinoma to adenocarcinoma due to changes in smoking habits and environmental exposures [17,18].

Male predominance (70%) observed in this study correlates with higher smoking prevalence among males [19]. The peak incidence in the 5th and 6th decades is also consistent with earlier studies [20].

The diagnostic accuracy of 93.3% observed in this study is comparable to reported values ranging between 85–95% [21]. High sensitivity indicates the reliability of CT-guided FNA in detecting malignancies.

Benign lesions included tuberculosis and inflammatory conditions, reflecting the endemic nature of infectious diseases in India [22].

Complication rate was low (10%), with pneumothorax being the most common, which is in agreement with other studies reporting rates between 5–15% [23].

CT guidance improves lesion localization and reduces sampling error, making it superior to blind or fluoroscopic techniques [24].

Overall, CT-guided FNA is a safe, accurate, and cost-effective diagnostic modality that significantly reduces the need for surgical biopsy [25].

Conclusion

CT-guided FNA is a highly effective diagnostic technique for lung masses with excellent accuracy and minimal complications. It plays a crucial role in early diagnosis and management of lung lesions.

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