The Journal of Teachers Association

ISSN 1019-8555 (Print) & ISSN 2408-8854 (Online)
Frequency: Bi-Annual
DOI: https://doi.org/10.70818/taj.v37i2.0326

OPEN ACCESS

Website: www.tajrmc.com
Email: editor@tajrmc.com
Volume-37 | Issue-2 | Jul-Dec 2024

CT Guided Fine Needle Aspiration Cytology and Radiologic Correlation in Diagnosing Lung Neoplasms

Shajia Chowdhury*[1], Nurul Quayum Mohammad Musallin[2], Abed Hossain[1], Suchanda Ray[1], Kona Gosh[3]

[1] Department of Pathology, Jalalabad Ragib-Rabeya Medical College, Sylhet
[2] Department of Surgery, Jalalabad Ragib-Rabeya Medical College, Sylhet
[3] Department of Radiology, Jalalabad Ragib-Rabeya Medical College, Sylhet

Abstract: ***Background:*** Lung cancer represents the leading cause of cancer incidence and mortality among men globally, while for women, it ranks as the third most prevalent cause of cancer incidence and the second leading cause of cancer-related deaths. This study aimed to assess the performance of CT-guided fine needle aspiration cytology (FNAC) and radiology and their correlation in diagnosing lung carcinoma. CT guided biopsy was considered as gold standard. ***Methods:*** This cross-sectional observational study was conducted at the Department of Pathology in Jalalabad Ragib-Rabeya Medical College and Hospital, from January 2023 to December 2023 on 60 patients having suspected lung mass were purposively selected as study subjects. ***Result:*** Cytology has a sensitivity of 93.48% and a specificity of 50.00%, with a positive predictive value (PPV) of 86.00% and a negative predictive value (NPV) of 70.00%. Radiology shows a sensitivity of 89.13% and a specificity of 50.00%, with a PPV of 85.42% and an NPV of 58.33%. ***Conclusion:*** This study concludes that, while both cytology and radiology contribute valuable information in diagnosing cancerous lesions, their combined use may enhance diagnostic accuracy, with each test offering unique strengths. This underscores the importance of integrating multiple diagnostic modalities to optimize patient care and management.

Keywords: FNAC, Radiology, Lung neoplasm, Sensitivity, Specificity, PPV, NPV.

Original Research Article

Correspondence:
Dr. Shajia Chowdhury
Associate Professor,
Department of Pathology,
Jalalabad Ragib-Rabeya Medical College,
Sylhet, Bangladesh

How to cite this article:
Chowdhury S, Musallin NQ, Hossain MA, Ray S, Gosh K; CT Guided Fine Needle Aspiration Cytology and Radiologic Correlation in Diagnosing Lung Neoplasms. Taj 2024;37 (2): 328-334

Article history:
Received: August 17, 2024
Accepted: November 14, 2024
Published: December 31, 2024

Article at a glance:

Study Purpose: *The purpose of this study is to evaluate the diagnostic accuracy and effectiveness of CT-guided fine needle aspiration cytology (FNAC) in identifying lung neoplasms, and to assess its correlation with radiologic imaging findings for improved diagnosis and clinical decision-making.*

Key findings: *CT-guided fine needle aspiration cytology (FNAC) demonstrates high diagnostic accuracy in identifying lung neoplasms, with strong correlation to radiologic findings, supporting its role as a reliable, minimally invasive diagnostic tool.*

Newer findings: *Recent data from the study suggest that integrating radiologic characteristics—such as lesion size, location, and density—with cytological analysis improves early detection rates and helps in differentiating between benign and malignant lesions more effectively than cytology alone.*

Abbreviations: *FNAC: Fine Needle Aspiration Cytology, PPV: Positive Predictive Value.*

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INTRODUCTION

Lung cancer ranks as the second most common cancer among both men and women. The primary risk factor associated with lung cancer is smoking, which contributes to approximately 75-80% of lung cancer-related fatalities. There are two main types of lung cancer: small-cell carcinomas and non-small-cell carcinomas, with the latter being more prevalent, accounting for up to 75% of cases. Diagnosis of lung cancer typically involves various methods such as chest radiography, sputum cytology, bronchoscopy, and needle biopsy, among others.[1] Since 1985, lung cancer has consistently held the title of the most prevalent cancer worldwide, both in terms of new cases and fatalities. It stands as the leading cause of new

cancer diagnoses globally, with approximately 1,350,000 new cases annually, constituting 12.4% of all new cancer cases. Additionally, it remains the primary contributor to cancer-related mortality, claiming approximately 1,180,000 lives each year, which represents 17.6% of total cancer deaths.[2] Understanding its detailed pathogenesis, implementing effective early detection methods, and utilizing appropriate medication are essential for successful lung cancer treatment. Early diagnosis plays a critical role, particularly in screening high-risk populations such as smokers and individuals exposed to hazardous environments like fumes, oil fields, or toxic workplaces.

The creation of accurate diagnostic tests is crucial in the successful treatment of lung cancer. CT scans surpass plain radiography and tomography in peripheral lung lesion detection.[3, 4] With the advancement in CT technology, detection of small pulmonary nodules has become better, but it remains challenging to distinguish between malignancy and benign lesions.[5] CT-guided fine-needle aspiration biopsy (FNAB) is an accurate and safe method to evaluate pulmonary nodules.[5] CT-guided fine needle aspiration cytology (FNAC) of lung lesions has quickly gained prominence as a minimally invasive, cost-effective, rapid, and reasonably accurate diagnostic tool for lung lesions.[6] Routine noninvasive radiographic imaging, including chest CT and positron emission tomography (PET) scans, is commonly conducted in patients suspected of having metastatic lung cancer. CT scans of the chest can detect hilar and mediastinal adenopathy, as well as liver or adrenal involvement. While the accuracy of CT in the mediastinum is reported to be 88% (with 80% sensitivity and 100% specificity), PET enhances staging. Integrated CT/PET scanners demonstrate improved test characteristics compared to CT or PET alone.[7,8] CT-guided fine-needle aspiration cytology (FNAC) is regarded as a straightforward, safe, and reliable procedure, demonstrating high diagnostic efficacy.[9] The aim of the study is to assess the performance of CT-guided fine needle aspiration cytology (FNAC) and radiology and their correlation in diagnosing lung carcinoma where CT-guided biopsy was considered as gold standard.

METHODS

A cross-sectional study was conducted from January to December 2023 at JRRMCH, Sylhet, Bangladesh, among 60 suspected neoplastic pulmonary mass lesion patients, referred from Medicine, Oncology, and OPD. CT-guided FNAC and core biopsy were done by a pathologist under the supervision of an experienced radiologist. Core biopsy provided larger tissue samples for histopathological study, in addition to FNAC. FNAC was performed with a 22G spinal needle and core biopsy with an 18-gauge coaxial needle, both under CT guidance. Post-procedure, patients were observed for 2 hours, and minor hemorrhage and chest pain were managed conservatively. The clinical presentation of benign and malignant pulmonary lesions depends on the patient's history, symptoms, and laboratory findings. Benign lesions are typically described by indolent, non-progressive symptoms, lack of or minimal systemic signs, and absence of constitutional symptoms such as weight loss or night sweats.[10]

The malignant lesions also reveal in patients as hemoptysis, weight loss, chest pain, and respiratory distress.[11] Malignant cases are often seen with systemic symptoms of fatigue and anorexia.[12] The radiological diagnosis of benign and malignant lesions was based on characteristic imaging findings. Benign lesions generally appeared as well-defined, round, or oval masses with smooth margins and a lack of invasion into adjacent structures. They often exhibited features such as calcification, cavitation with thin walls, and homogeneous density. In contrast, malignant lesions displayed irregular or spiculated margins, rapid growth, invasion into surrounding tissues, and associated findings like mediastinal lymphadenopathy or pleural effusion.[10] CT scans were used to assess these features, aiding in differentiation between benign and malignant lesions before histopathological confirmation. All patients in this study underwent both CT-guided FNAC and core biopsy for the evaluation of pulmonary mass lesions. FNAC was used for cytological diagnosis, while biopsy provided histopathological diagnosis and lesion classification to enhance diagnostic accuracy. Inclusion criteria were suspected neoplastic lesions patients, any age, and consent, while exclusion criteria were chronic diseases or absence of consent.

Data were collected by interview and report using a pre-formatted questionnaire, and then analyzed using SPSS 26.0. Ethical clearance and informed consent were obtained from the participants.[11]

RESULTS

Table 1: Age and sex distribution of the respondents (N=60)

Characteristics	Number (%)
Age (Years)	
20-30	1(1.67)
30-39	2(3.33)
40-49	5(8.33)
50-59	16(26.67)
60-69	14(23.33)
70-79	10(16.67)
80-89	7(11.67)
90-100	5(8.33)
Sex	
Male	46(76.67)
Female	14(23.33)

In this series, most of the patients belonged to the 50-59 years of age group (16,26.67%), followed by 60-69 years age group (14,23.33%) and male was predominant (46,76.67%) (Table-1)

Table 2: Patients according to cytological findings (N=60)

Cytological finding	**Number (%)**
Squamous cell carcinoma	27(45.00)
Adenocarcinoma	5(8.33)
Small cell carcinoma	8(13.33)
Tuberculosis	2(3.33)
Inflammatory lesion	11(18.33)
Suspicious for malignancy	3(5.00)
Abscess	2(3.33)
Large cell carcinoma	1(1.67)
Metastatic squamous cell carcinoma	1(1.67)

It was observed that squamous cell carcinoma was the most predominant finding (27,45.00%), followed by the inflammatory lesion (11,18.33%), small cell carcinoma (8,13.33%), and adenocarcinoma (5,8.33%) (Table-2).

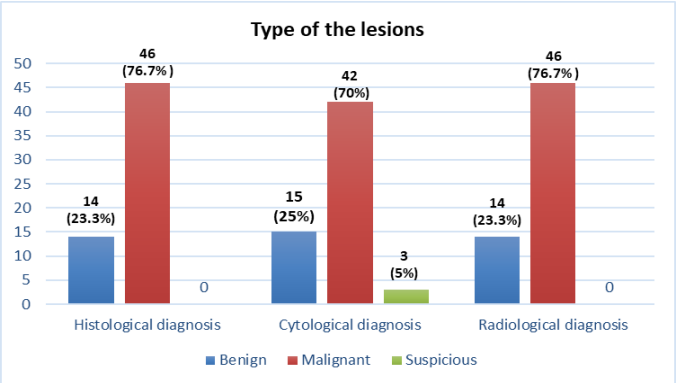

Figure 1: Types of lesions in Cytology, Radiology and Histopathological (n=60)

In this series, on cytology, benign lesion was found in 15 (25.00%) cases and malignant in 42 (70.00%) cases. Moreover, 3 (5.00%) cases were suspicious of having malignancy. On the other hand, benign lesion was found in 14 (23.33%) cases and malignant in 46 (76.67%) cases in radiology. Among the lesions, 76.7% were malignant and 23.3% were benign following the histopathological diagnosis. (Figure-1).

Table 3: Correlation of Radiological diagnosis with histopathology as the gold standard (N=60)

Variables	Histopathologically Malignant	Histopatholgically Benign
Radiologically Malignant	41 (TP)	7 (FP)
Radiologically Benign	5 (FN)	7 (TN)

Out of 60 cases, radiology correctly identified 41 malignant cases (true positives) and 7 benign cases (true negatives). However, 7 benign cases were incorrectly classified as malignant (false positives), and 5 malignant cases were missed (false negatives). These results reflect the diagnostic accuracy of radiology in detecting lung neoplasms (Table 3).

Table 4: Correlation of Cytological diagnosis with histopathology as the gold standard (N=60)

Variables	Histopathologically Malignant	Histopathological Benign
Cytologically Malignant	43 (TP)	7 (FP)
Cytologically Benign	3 (FN)	7 (TN)

Among 60 cases, cytology correctly identified 43 malignant cases (true positives) and 7 benign cases (true negatives). However, 7 benign cases were incorrectly labelled as malignant (false positives), and 3 malignant cases were missed (false negatives). These findings demonstrate the diagnostic performance of cytology in identifying lung neoplasms (Table 4).

Table 5: Performance of diagnostic tests with histopathology as the gold standard (N=60)

Criteria	Formula	Radiology Performance	Cytology performance
Sensitivity	TP / (TP + FN)	89.13%	93.48%
Specificity	TN / (TN + FP)	50.00%	50.00%
PPV (Positive Predictive Value)	TP / (TP + FP)	85.42%	86.00%
NPV (Negative Predictive Value)	TN / (TN + FN)	58.33%	70.00%
Accuracy	(TP + TN) / (TP + TN + FP + FN)	80.00%	83.33%

PPV; Positive predictive value
NPV; Negative predictive value

Radiology demonstrated a sensitivity of 89.13%, a specificity of 50.00%, a positive predictive value (PPV) of 85.42%, a negative predictive value (NPV) of 58.33%, and an accuracy of 80.00%. In comparison, cytology showed slightly higher sensitivity at 93.48%, the same specificity of 50.00%, a PPV of 86.00%, an NPV of 70.00%, and a higher overall accuracy of 83.33% (Table-5).

DISCUSSION

In this series, the majority of the patients belonged to the 50-59 years of age group (16,26.67%), followed by 60-69 years age group (14,23.33%). In the study of Youlden DR *et al*, among individuals diagnosed with lung cancer, 5% were found in the age range of 0 to 44 years, 14% in

the 45 to 54 age bracket, 25% in the 55 to 64 age group, and 55% in those aged 65 years and older.[14] In this study the majority of the patients were male (46,76.67%) in this study which was similar to the study of Torre LA *et al*.[15] It was observed that squamous cell carcinoma was the most predominant finding (27,45.00%), followed by the inflammatory lesion (11,18.33%), small cell carcinoma (8,13.33%), and adenocarcinoma (5,8.33%). Lung cancer presents primarily in two forms: Non-Small Cell Lung Cancer (NSCLC), affecting 85% of patients, and Small Cell Lung Cancer (SCLC), affecting the remaining 15%. WHO further categorizes NSCLC into three primary types: adenocarcinoma, squamous cell carcinoma, and large cell carcinoma. Among these, adenocarcinoma is the most prevalent, constituting roughly 40% of all lung cancer cases.[14] In this study, the most affected lobe was the right lower (13,21.67%), followed by, the right upper lobe (12, 20.00%) and hilum (12, 20.00%). The left lower lobe was affected in 11 (18.33%) patients mirroring another study.[16] In this series, benign malignancy was found in 15 (25.00%) cases and malignant in 42 (70.00%) cases. Moreover, 3 (5.00%) cases were suspicious of having malignancy. A study by Gupta *et al* also showed a similar picture.9 It was observed that cytology has a sensitivity of approximately 93.48% and a specificity of approximately 50%. Radiology has a sensitivity of 89.13% and a specificity of approximately 50%. Cytology has a PPV of approximately 86.00% and an NPV of 70.00%. Radiology has a PPV of approximately 85.42% and an NPV of 58.33%. An additional study indicates that image-guided fine-needle aspiration cytology (FNAC) for diagnosing malignant pulmonary lesions achieves a sensitivity of at least 92% and a specificity of at least 96%. It is a reliable diagnostic test although its accuracy is limited by technical difficulties in obtaining an adequate sample.17 CT detects early lung cancers with a high rate of detection of benign nodules.18 Another study found CT sensitivity 90.9% and specificity 87.2%, as in this study.19,22 PET/CT assessment by Kagna O *et al*. showed sensitivity 94%, specificity 70%, accuracy 80%, PPV 66%, and NPV 95%.20 FNAC positive predictive value was 98.6% in another study.[21,33]

Limitations of the study

The study was carried out in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

This study concludes that, while both cytology and radiology contribute valuable information in diagnosing cancerous lesions, their combined use may enhance diagnostic accuracy, with each test offering unique strengths. This underscores the importance of integrating multiple diagnostic modalities to optimize patient care and management. Furthermore, the Chi-square test results indicate a significant association between the outcomes of cytology and radiology tests. This suggests that the results of one test are not independent of the results of the other, indicating potential complementary roles in diagnosis.

Recommendation

It is recommended to adopt an integrated approach that combines cytology and radiology to enhance diagnostic accuracy. Clinicians should carefully consider the strengths and limitations of each test, balancing their benefits and potential drawbacks in the decision-making process. Diagnostic strategies should be tailored to the individual patient's risk factors, ensuring a personalized approach that improves precision and effectiveness. In cases where results are inconclusive, structured follow-up plans should be implemented to facilitate timely reassessment and intervention. Additionally, continuous quality improvement should be prioritized to optimize diagnostic performance and enhance overall patient care. Moreover, further studies should be conducted involving a large sample size and multiple centres to get robust data.

Funding: No funding sources.
Conflict of interest: None declared.
Ethical approval: The study was approved by the Institutional Ethics Committee.

Authors' contributions

SC, NQMM: Concept and design, data acquisition, interpretation and drafting. MAH, SR and KG: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

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The Journal of Teachers Association
Abbreviated Key Title: TAJ
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