

Original Research Article

Radiological evaluation and computed tomography-guided biopsy of pulmonary and mediastinal masses: a prospective study with histopathological correlation

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ABSTRACT

Background: Pulmonary and mediastinal masses constitute a significant diagnostic challenge in clinical practice. Computed tomography (CT) is the cornerstone of radiological assessment, while CT-guided biopsy serves as the gold standard for definitive tissue characterization. Objectives of the study was to evaluate CT as an imaging modality and to assess the diagnostic accuracy and safety profile of CT-guided biopsy in pulmonary and mediastinal masses, using histopathology as the reference standard.

Methods: This prospective observational study enrolled 35 patients aged ≥ 18 years with pulmonary or mediastinal masses referred for CT-guided biopsy at the Department of Radiodiagnosis, Jubilee Mission Medical College and Research Institute, Thrissur, Kerala, India, from January 2023 to June 2024. CT features including lesion site, margins, enhancement pattern, and associated findings were documented. Tissue samples were correlated with histopathological diagnosis.

Results: Patients were predominantly male (54.3%) and aged above 60 years (60.0%). Pulmonary lesions predominated (91.4%). CT categorized 85.7% of lesions as malignant; histopathology confirmed malignancy in 77.1%, with adenocarcinoma being the most frequent diagnosis (37.1%). The CT–histopathology correlation rate was 88.6%. CT demonstrated sensitivity of 96.3%, specificity of 50.0%, positive predictive value of 86.7%, and negative predictive value of 80.0%. Biopsy adequacy was 94.3%. Complications were limited to mild pneumothorax in 14.3%; no major adverse events occurred.

Conclusion: CT is a highly sensitive modality for evaluating thoracic masses, and CT-guided biopsy is safe with high diagnostic adequacy. The strong radiological–pathological concordance supports an integrated multidisciplinary approach in managing pulmonary and mediastinal masses.

Keywords: CT-guided biopsy, Pulmonary mass, Mediastinal mass, Diagnostic accuracy

INTRODUCTION

Pulmonary and mediastinal masses encompassing a spectrum from benign inflammatory lesions to aggressive malignancies represent a substantial diagnostic challenge in contemporary clinical practice. Lung cancer remains the leading cause of cancer-related mortality worldwide, with approximately 2.2 million new cases and 1.8 million deaths recorded annually, underscoring the critical importance of early and accurate diagnosis.¹ Mediastinal

masses, though less frequent, present unique challenges due to their anatomical location and diverse histological origins, including lymphomas, thymomas, germ cell tumours, and metastatic disease.²

Computed tomography (CT) has transformed the radiological approach to thoracic pathology. Modern multidetector CT scanners provide high-resolution anatomical detail, enabling precise characterization of lesion size, morphology, attenuation, margins, and

relationship to adjacent structures.³ Radiological features such as calcification, enhancement patterns, margin characteristics, and the presence of cavitation or ground-glass opacity offer important diagnostic clues. However, despite technological advances, CT imaging alone frequently lacks the specificity necessary for a conclusive diagnosis, particularly in differentiating benign from malignant aetiologies.⁴

CT-guided percutaneous needle biopsy has emerged as a safe, minimally invasive, and highly accurate tissue acquisition technique. Its advantages over surgical biopsy include reduced morbidity, shorter hospital stays, lower cost, and the ability to be performed under local anaesthesia. CT guidance ensures real-time visualisation of the needle trajectory, enabling precise targeting while avoiding vital structures.⁵⁻⁷ The diagnostic yield of CT-guided biopsy ranges from 80% to 95%, with sensitivity and specificity for malignancy exceeding 90% in most series.^{8,9}

Radiological–pathological correlation is integral to an optimal diagnostic strategy. It validates imaging interpretations, identifies sampling discordance, and supports the multidisciplinary management model increasingly required in contemporary oncology.

In addition to confirming diagnosis, adequate tissue sampling provides material for immunohistochemical staining, molecular profiling, and genetic testing—essential for treatment selection in lung cancer and lymphoproliferative disorders.^{10,11}

The most common complication of CT-guided biopsy is pneumothorax, occurring in 15–40% of patients, though only a minority require intervention. Haemorrhage, air embolism, and needle tract seeding are additional, less frequent risks.^{12,13} Lesion size, location, and surrounding parenchymal quality significantly influence complication rates and diagnostic yield.¹⁴

This study aimed to comprehensively evaluate the radiological features of pulmonary and mediastinal masses on CT, assess the diagnostic accuracy and safety profile of CT-guided biopsy, and systematically correlate imaging findings with histopathological diagnoses.

METHODS

This prospective observational study was conducted at the department of radiodiagnosis, Jubilee mission medical college and research institute, Thrissur, Kerala, India, over a period of 18 months from 01 January 1st 2024, to June 31st 2025, following institutional ethical committee clearance. Sample size was calculated based on a CT diagnostic sensitivity of 97% reported by Kuniyil et al in a comparable study of lung and mediastinal mass evaluation.¹⁵ Accordingly, a minimum of 35 patients was required for the study.

A total of 35 patients aged 18 years and above, with radiologically diagnosed pulmonary or mediastinal masses and referred for CT-guided biopsy, were included. Histopathological examination was used as the reference standard for diagnosis. Patients with lesions originating from vascular or bony structures, uncorrected coagulation abnormalities, non-cooperative behaviour, and pregnant patients were excluded. Informed written consent was obtained from all participants before enrolment.

All enrolled patients underwent computed tomography evaluation using a standardized protocol. Radiological parameters systematically recorded included lesion site and mediastinal compartment, size, morphology, margin characteristics, enhancement pattern on contrast-enhanced CT, presence of calcification or cavitation, mediastinal lymphadenopathy, pleural involvement, and associated findings. CT-guided percutaneous needle biopsy was performed under strict aseptic precautions following verification of coagulation parameters and relevant laboratory investigations. The needle trajectory was carefully planned to ensure the safest possible path while avoiding major vessels and vital structures.

Obtained tissue specimens were immediately submitted for histopathological examination, and CT diagnoses were systematically correlated with histopathological findings for each case.

Data were entered in Microsoft Excel and analysed using statistical package for the social sciences (SPSS) version 26. Descriptive statistics including mean, standard deviation, frequencies, and percentages were used to summarise demographic, clinical, radiological, and histopathological variables.

The diagnostic performance of CT was assessed by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), with histopathological diagnosis as the gold standard. A *p* value of less than 0.05 was considered statistically significant.

RESULT

The study included 35 patients. the majority (60.0%) were aged above 60 years, with an additional 28.6% in the 51–60 age group. a slight male predominance was observed (54.3% males vs. 45.7% females). cough was the most common presenting symptom (42.9%), followed by dyspnoea (25.7%) and chest pain (20.0%) as shown in Table 1.

Pulmonary lesions predominated (91.4%); mediastinal lesions accounted for 8.6%. among pulmonary lesions, the right upper and right lower lobes were each affected in 31.3% of cases, followed by the left lower lobe (18.8%). smooth margins were observed in 54.3% and spiculated margins in 45.7% of lesions. heterogeneous

enhancement was the predominant pattern (60.0%). calcification and necrosis were each identified in 11.4% of cases. associated CT findings were present in 80.0% of cases, most commonly lung collapse (28.6%) and combined collapse with pleural effusion (40.0%).

Table 1: Sociodemographic profile of study participants (n=35).

Characteristic	Category	N (%)
Age (years)	≤40	2 (5.7)
	41–50	2 (5.7)
	51–60	10 (28.6)
	>60	21 (60.0)
Gender	Male	19 (54.3)
	Female	16 (45.7)

Table 2: CT morphological and enhancement characteristics of lesions of study participants (n=35).

CT feature	Category	N (%)
Margin	Smooth	19 (54.3)
	Spiculated	16 (45.7)
Enhancement	Homogeneous	14 (40.0)
	Heterogeneous	21 (60.0)
Internal feature	Calcification	4 (11.4)
	Necrosis	4 (11.4)
	Cavitation	1 (2.9)
	Non-specific	24 (68.6)

Based on CT evaluation, 85.7% of lesions were classified as malignant, 11.4% as infective, and 2.9% as benign. primary lung malignancy was the most frequent CT diagnosis (60.0%), followed by infective aetiology (11.4%) and metastatic or mediastinal tumours (8.6% each). adequate tissue samples were obtained in 94.3% of procedures.

Histopathology confirmed malignancy in 77.1% of cases, while benign and infective lesions each constituted 11.4%. adenocarcinoma was the most frequent diagnosis

Table 4: Histopathological diagnosis and CT–histopathology correlation of study participants (n=35).

Variable	Category	N (%)
Histopathology category	Malignant	27 (77.1)
	Benign	4 (11.4)
	Infective/inflammatory	4 (11.4)
Histopathological diagnosis	Adenocarcinoma	13 (37.1)
	Non-small cell lung carcinoma	4 (11.4)
	Small cell lung carcinoma	2 (5.7)
	Other malignant tumours*	8 (22.9)
	Benign lesions	4 (11.4)
	Infective/inflammatory	4 (11.4)
	CT–histopathology correlation	Concordant
	Discordant	4 (11.4)

(37.1%), followed by other malignant tumours including mesothelioma, neuroendocrine tumour, and undifferentiated carcinoma (22.9%), and non-small cell lung carcinoma (11.4%).

CT–histopathology correlation was observed in 88.6% of cases (31/35). a statistically significant association was found between CT and histopathological diagnoses ($\chi^2 = 3.924, p=0.03$).

Table 3: CT diagnosis and biopsy adequacy of study participants (n=35).

Variable	Category	N (%)
CT category	Malignant	30 (85.7)
	Infective	4 (11.4)
	Benign	1 (2.9)
CT diagnosis	Primary lung malignancy	21 (60.0)
	Infective aetiology	4 (11.4)
	Metastatic lesions	3 (8.6)
	Mediastinal tumours	3 (8.6)
	Mass-like consolidation	2 (5.7)
	Others	2 (5.7)
Biopsy adequacy	Adequate	33 (94.3)
	Inadequate	2 (5.7)

Among lesions diagnosed as malignant on CT, 86.7% were confirmed malignant on histopathology; among those classified as non-malignant on CT, 80.0% were confirmed non-malignant histopathologically.

CT demonstrated a sensitivity of 96.3%, specificity of 50.0%, PPV of 86.7%, and NPV of 80.0% for detecting malignancy relative to histopathology.

Complications occurred in 14.3% of patients, all consisting of mild pneumothorax that resolved spontaneously without intervention. no major complications were encountered.

Table 5: Diagnostic performance of CT using histopathology as gold standard for study participants.

Parameter	Value (%)
Sensitivity	96.3
Specificity	50.0
Positive predictive value (PPV)	86.7
Negative predictive value (NPV)	80.0

DISCUSSION

The present study comprehensively evaluated the role of CT in characterizing pulmonary and mediastinal masses and the diagnostic performance of CT-guided biopsy with histopathological correlation. A sensitivity of 96.3% and an overall CT–histopathology concordance of 88.6% demonstrate the critical importance of radiological assessment in guiding clinical decision-making for these complex lesions.

The demographic profile revealed a predominance of elderly patients, with 60.0% aged above 60 years. This aligns with global cancer epidemiology, particularly lung cancer, which predominantly affects older adults with a median age at diagnosis exceeding 65 years.¹ The slight male predominance (54.3%) reflects the established gender distribution of lung pathology, although this gap has been narrowing due to changing smoking patterns and environmental exposures.

Cough was the most common presenting symptom (42.9%), consistent with prior literature. The substantial proportion of patients presenting with dyspnoea (25.7%) and chest pain (20.0%) highlights the functional impairment caused by space-occupying thoracic lesions, particularly through mass effect, airway obstruction, or pleural involvement.

Pulmonary lesions constituted 91.4% of cases compared to 8.6% mediastinal. This distribution differs from studies with broader mediastinal referral patterns, such as Kaur et al., who reported anterior mediastinal involvement in 38.3% of their cohort.¹⁶ The right upper and right lower lobes were the most frequently involved (31.3% each), consistent with the known anatomical predisposition of bronchogenic carcinomas, which tend to favour upper lobes due to differential carcinogen deposition and ventilation patterns.

Spiculated margins, observed in 45.7% of lesions, represent a well-established radiological predictor of malignancy, reflecting infiltrative tumour growth. However, smooth margins do not exclude malignancy, as certain histological subtypes—particularly well-differentiated adenocarcinomas with lepidic growth—may present with well-defined contours. Heterogeneous enhancement, the predominant pattern (60.0%), correlated with internal necrosis or haemorrhage, features commonly associated with malignant masses. These

findings align with Tran Anh et al, who emphasized the utility of multi-slice CT in characterizing tissue density and enhancement patterns for differentiating benign from malignant mediastinal masses.¹⁷

Associated CT findings were present in 80.0% of cases, with collapse being the most common (28.6%), frequently accompanied by pleural effusion. The high frequency of associated findings reflects the advanced stage at presentation in many patients and underscores the capacity of thoracic masses to substantially alter normal anatomical relationships.

The CT categorization of malignancy in 85.7% of lesions is comparable to the 85.1% reported by Piplani et al in their series of transthoracic CT-guided fine needle aspirations.¹⁸ The relatively low proportion of benign lesions highlights the effectiveness of non-invasive imaging criteria in identifying lesions with low malignancy probability that may be managed conservatively.

Biopsy adequacy of 94.3% compares favourably with reported non-diagnostic rates of 5–15% in the literature.⁴ Histopathological examination confirmed malignancy in 77.1% of cases, with adenocarcinoma as the most frequent diagnosis (37.1%), reflecting contemporary global trends. The CT–histopathology concordance of 88.6% is comparable to the 87.5% diagnostic accuracy reported by Gadia et al. in mediastinal mass evaluation.¹⁹

The complication rate of 14.3%—exclusively mild pneumothorax without the need for intervention—compares favourably with the pooled pneumothorax incidence of 25.9% reported by Lee et al in their systematic review and meta-analysis of CT-guided core needle biopsy for mediastinal masses.²⁰ This favourable safety profile may reflect meticulous procedural planning, careful patient selection, use of coaxial technique, and structured post-procedure management.

The statistically significant association between CT and histopathological diagnoses ($\chi^2=3.924$, $p=0.03$) validates the role of CT in differential diagnosis formulation and biopsy planning. Ahn et al demonstrated that CT significantly outperformed chest radiography in predicting histology of anterior mediastinal masses, with correct first-choice diagnosis in 48% of CT evaluations compared to 36% for radiographs.²¹ As noted by Petranovic et al., diagnostic yield varies by histological entity, with thymic neoplasms achieving higher diagnostic rates while lymphomas show relatively lower yields, primarily due to the need for larger tissue samples and intact architecture for immunophenotyping.²² Discordant cases (11.4%) underscore the importance of integrating clinical, radiological, and pathological information in a multidisciplinary framework.

This study had several limitations. Pulmonary lesions predominated, restricting subgroup analysis of

mediastinal masses. Selection bias is possible, as only patients referred for CT-guided biopsy were included. The relatively low specificity of CT (50.0%) may be due to overlapping imaging features between malignant, benign, and infective lesions. Not all radiological–pathological discordances were confirmed with repeat biopsy or surgery, potentially affecting diagnostic validation. Advanced imaging modalities such as PET-CT and radiomics were not included, and the lack of long-term follow-up limits assessment of delayed diagnoses and false-negative cases.

CONCLUSION

CT is a highly sensitive imaging modality (sensitivity 96.3%) for evaluating pulmonary and mediastinal masses and demonstrates strong concordance with histopathological diagnosis (88.6%). CT-guided biopsy provides a high diagnostic adequacy rate (94.3%) with an acceptable safety profile, with complications limited to minor, self-resolving pneumothorax (14.3%) and no major adverse events. Adenocarcinoma was the most frequent histopathological diagnosis, and primary lung malignancy predominated on CT assessment. The combination of CT imaging with CT-guided percutaneous biopsy constitutes an accurate, safe, and minimally invasive diagnostic pathway for thoracic masses. A multidisciplinary approach integrating radiological assessment with histopathological correlation is recommended for optimal patient management. Future studies with larger, multicentre cohorts and longer follow-up are warranted to validate and extend these findings.

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