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Research Article

Diagnostic Accuracy of Multidetector Computed Tomography in the Evaluation of Lung Masses with Histopathological Correlation

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Abstract: ***Introduction:*** Lung masses represent an important diagnostic challenge because benign, infective, inflammatory, and malignant lesions may show overlapping clinical and radiological features. Multidetector computed tomography (MDCT) provides detailed assessment of lesion morphology, enhancement, local extension, lymphadenopathy, and metastasis, but histopathology remains the gold standard for definitive diagnosis.**Objective:** To evaluate the diagnostic accuracy of MDCT in the characterization of lung masses using histopathological examination as the reference standard.**Methods:** This hospital-based observational study included 35 patients with suspected lung masses who underwent contrast-enhanced MDCT thorax followed by histopathological confirmation. MDCT findings including lesion location, margins, enhancement, necrosis, calcification, lymphadenopathy, and metastasis were correlated with histopathological diagnosis.**Results:** Histopathology confirmed malignancy in 24 cases (68.6%) and benign disease in 11 cases (31.4%). Adenocarcinoma was the most common malignant subtype, while tubercular granuloma was the most frequent benign lesion. Spiculated/lobulated margins, contrast enhancement, necrosis, lymphadenopathy, central location, smoking status, and metastasis showed significant association with malignancy, whereas smooth margins and calcification favoured benign etiology. MDCT showed complete concordance with histopathology, with 100% sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy.**Conclusion:** MDCT is a highly useful imaging modality for characterization of lung masses and provides valuable information for diagnosis, staging, and biopsy planning. Histopathological confirmation remains essential for final diagnosis.

Keywords: Lung mass; Multidetector computed tomography; MDCT; Histopathology; Lung cancer; Pulmonary mass; Diagnostic accuracy.

INTRODUCTION

Lung masses represent a clinically important and radiologically challenging group of thoracic lesions because they include a wide spectrum of benign, infective, inflammatory, metastatic, and primary malignant conditions. In thoracic imaging terminology, a pulmonary mass is generally defined as a focal rounded pulmonary opacity measuring more than 3 cm in diameter, while smaller lesions are categorized as nodules.[1] Although this distinction is primarily size based, the clinical significance of a lung mass lies in its relatively higher probability of malignancy and the need for prompt characterization. Accurate differentiation between benign and malignant lung masses is essential because it directly influences the need for biopsy, staging evaluation, surgical planning, oncological treatment, or conservative follow-up.

Lung cancer remains one of the most important causes of cancer-related morbidity and mortality worldwide. According to recent GLOBOCAN estimates, lung cancer accounted for nearly 2.5 million new cases globally in 2022 and remained the leading cause of cancer death.[2] Tobacco smoking continues to be the most established risk factor, mediated through exposure to carcinogens such as polycyclic aromatic hydrocarbons and nitrosamines, which induce genetic and molecular alterations in bronchial epithelium.[3] However, the epidemiology of lung cancer is changing, with an increasing proportion of cases being reported among non-smokers, particularly in Asian populations, where environmental pollution, passive smoking, occupational exposures, biomass fuel exposure, and driver mutations such as EGFR alterations may contribute to disease development.[4]

Histologically, lung cancers are broadly classified into non-small cell lung carcinoma and small cell lung

carcinoma. Non-small cell lung carcinoma accounts for the majority of cases and includes adenocarcinoma, squamous cell carcinoma, and large-cell carcinoma.[5] Adenocarcinoma is now the most common histological subtype in many populations and often presents as a peripheral lesion, whereas squamous cell carcinoma is more commonly central and may show cavitation. Small cell carcinoma is characterized by aggressive behaviour, early metastasis, and strong association with smoking.[5] Despite these broad clinicopathological patterns, imaging appearances may overlap, and histopathological confirmation remains the definitive standard for diagnosis and subtype classification.

Chest radiography is usually the first imaging investigation in patients with respiratory symptoms. However, its sensitivity is limited, particularly for small, central, obscured, or complex lesions. Cross-sectional imaging with computed tomography has therefore become central to the evaluation of suspected lung masses. Multidetector computed tomography (MDCT) provides rapid volumetric acquisition, thin-section imaging, high spatial resolution, and multiplanar reconstruction, allowing detailed assessment of lesion size, location, margins, internal architecture, enhancement pattern, relationship to bronchi and vessels, mediastinal extension, lymphadenopathy, pleural involvement, and distant thoracic spread.[6] Spiculated or lobulated margins, irregular contour, heterogeneous enhancement, thick-walled cavitation, necrosis, pleural retraction, vascular encasement, mediastinal invasion, lymphadenopathy, and metastasis favour malignancy.Dynamic contrast assessment further improves characterization, as malignant lesions commonly show increased enhancement due to tumour angiogenesis. Swensen et al. demonstrated that absence of significant enhancement, defined as enhancement of 15 HU or less, is strongly predictive of benignity in pulmonary nodules.[7]

The Indian setting poses a unique diagnostic challenge because tuberculosis, fungal infection, and chronic inflammatory lesions may closely resemble bronchogenic carcinoma. Tuberculomas may show irregular margins, necrosis, lymphadenopathy, and even contrast enhancement, while malignant lesions may occasionally demonstrate calcification or cavitation.[8] This overlap can lead either to delayed cancer diagnosis or unnecessary invasive intervention in benign disease.
MDCT also plays a major role beyond initial lesion detection. It helps evaluate mediastinal and hilar lymph nodes, chest wall and pleural invasion, vascular involvement, atelectasis, post-obstructive changes, and distant thoracic metastases. These features are critical for staging and therapeutic decision-making.[9] CT-based imaging has also been validated in lung cancer screening among high-risk populations; the National Lung Screening Trial demonstrated a reduction in lung-cancer mortality with low-dose CT compared with chest radiography.[10]

Despite major advances in imaging, histopathology remains the gold standard for definitive diagnosis. Tissue sampling through CT-guided biopsy, bronchoscopic biopsy, or FNAC provides confirmation of benign or malignant pathology and identifies tumour subtype, which is increasingly important in the era of targeted therapy and immunotherapy. However, imaging guides the decision to sample, selects the safest and most representative biopsy site, and provides staging information that histology alone cannot supply.

The present study was undertaken to evaluate the diagnostic role of MDCT in the characterization of lung masses by correlating MDCT findings with histopathological diagnosis. By assessing morphological and enhancement characteristics of lung masses and comparing them with tissue diagnosis, the study aims to determine the diagnostic accuracy of MDCT in differentiating benign from malignant lesions.

Methodology

This was a hospital-based observational cross-sectional study conducted in the Department of Radio-diagnosis of a tertiary-care teaching hospital to evaluate the diagnostic role of multidetector computed tomography (MDCT) in patients with lung masses and to correlate MDCT findings with histopathological diagnosis. The study included 35 patients who presented with clinically or radiologically suspected lung masses and underwent both contrast-enhanced MDCT thorax and histopathological confirmation. A consecutive sampling technique was used, enrolling all eligible patients during the study period until the required sample size was achieved.

Patients were included if they had a suspected lung mass, underwent contrast-enhanced MDCT thorax, had histopathological confirmation through CT-guided biopsy, bronchoscopy-guided biopsy, or FNAC, and provided written informed consent. Patients with contraindications to iodinated contrast, incomplete or motion-degraded MDCT scans, absence of histopathological examination, or unwillingness to participate were excluded. Institutional Ethics Committee approval was obtained before conducting the study.

All patients underwent MDCT using a multislice scanner in the supine position during full inspiration. The protocol included thin collimation of 1–1.25 mm, appropriate tube voltage, automatic tube current modulation, intravenous non-ionic iodinated contrast administration, arterial or venous phase acquisition as required, and multiplanar reconstructions in axial, sagittal, and coronal planes.

MDCT images were reviewed by experienced radiologists. The evaluated imaging features included lesion size, shape, location, margin characteristics,

contour, calcification, fat attenuation, necrosis, cavitation, enhancement pattern, air bronchogram, lymphadenopathy, pleural effusion, pleural or chest wall invasion, vascular invasion, collapse, consolidation, and satellite nodules. Enhancement of ≥15 HU after contrast was considered suspicious. Findings were recorded in a predefined structured proforma.

Histopathology was used as the reference standard for final diagnosis. The primary outcomes were the diagnostic accuracy, sensitivity, specificity, positive predictive value, and negative predictive value of MDCT in differentiating benign and malignant lung masses. Secondary outcomes included the distribution of benign and malignant lesions, association of MDCT findings with histological subtypes, and detection of metastatic involvement. Data were analyzed using standard statistical software. Associations between MDCT features and histopathological diagnosis were tested using the chi-square test or Fisher's exact test, and a p-value <0.05 was considered statistically significant.

RESULTS

A total of 35 patients with suspected lung masses underwent MDCT evaluation followed by histopathological confirmation. Of these, 24 cases (68.6%) were malignant and 11 cases (31.4%) were benign. Male predominance was observed, with 23 males (65.7%) and 12 females (34.3%). Smoking was present in 17 patients (48.6%), and all smokers in the study were found to have malignant lesions. The most common clinical symptom was cough (97.1%), followed by weight loss (68.6%), chest pain (51.4%), dyspnea (48.6%), hemoptysis (40.0%), and fever (17.1%).

Table 1. Baseline demographic and clinical profile of study subjects

Variable	Category	n	%
Sex	Male	23	65.7
	Female	12	34.3
Smoking status	Smoker	17	48.6
	Non-smoker	18	51.4
Clinical symptoms	Cough	34	97.1
	Hemoptysis	14	40.0
	Dyspnea	17	48.6
	Chest pain	18	51.4
	Fever	6	17.1
	Weight loss	24	68.6

On MDCT, peripheral lesions were more common than central lesions, being observed in 21 cases (60.0%), while central lesions were seen in 14 cases (40.0%). Regarding margin characteristics, spiculated margins were the most frequent finding, present in 17 cases (48.6%), followed by smooth margins in 11 cases (31.4%) and lobulated margins in 7 cases (20.0%).

Histopathological examination showed that malignant lesions constituted the majority, accounting for 24 cases (68.6%), while benign lesions accounted for 11 cases (31.4%). Among histological types, adenocarcinoma was the most common diagnosis, seen in 10 cases, followed by squamous cell carcinoma in 9 cases, tubercular granuloma in 8 cases, small cell carcinoma in 3 cases, inflammatory lesion in 2 cases, metastasis in 2 cases, and hamartoma in 1 case.

Table 2. Distribution of MDCT lesion characteristics

MDCT characteristic	Category	n	%
Lesion location	Central	14	40.0
	Peripheral	21	60.0
Margin type	Smooth	11	31.4
	Lobulated	7	20.0
	Spiculated	17	48.6

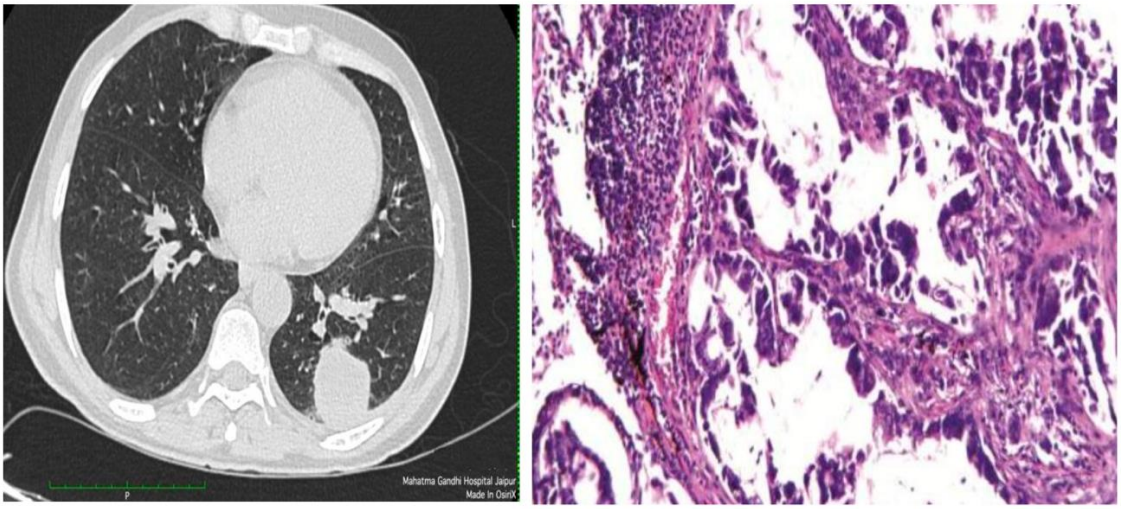

Figure 1.shows well defined peripherally enhancing centrally necrotic mass lesion with spiculated margin is seen in superior segment of left lower lobe abutting the posterior pleurawith adjacent pleural thickening. No calcification or fatty attenuation is seen within thelesion. No chest wall invasion or rib erosion is seen.

Table 3. Histopathological diagnosis and histological types

Histopathological finding	**n**	**%**
Malignant	24	68.6
Benign	11	31.4
Histological type		
Adenocarcinoma	10	28.6
Squamous cell carcinoma	9	25.7
Small cell carcinoma	3	8.6
Metastasis	2	5.7
Tubercular granuloma	8	22.9
Hamartoma	1	2.9
Inflammatory lesion	2	5.7

Smoking status, lesion location, and margin characteristics showed statistically significant associations with malignancy. All smokers had malignant lesions, while all benign lesions occurred among non-smokers ($p = 0.0004$). All central lesions were malignant, whereas peripheral lesions included both benign and malignant lesions ($p = 0.003$). Margin characteristics showed a highly significant association, with all smooth-margin lesions being benign, while all lobulated and spiculated lesions were malignant ($p < 0.0001$).

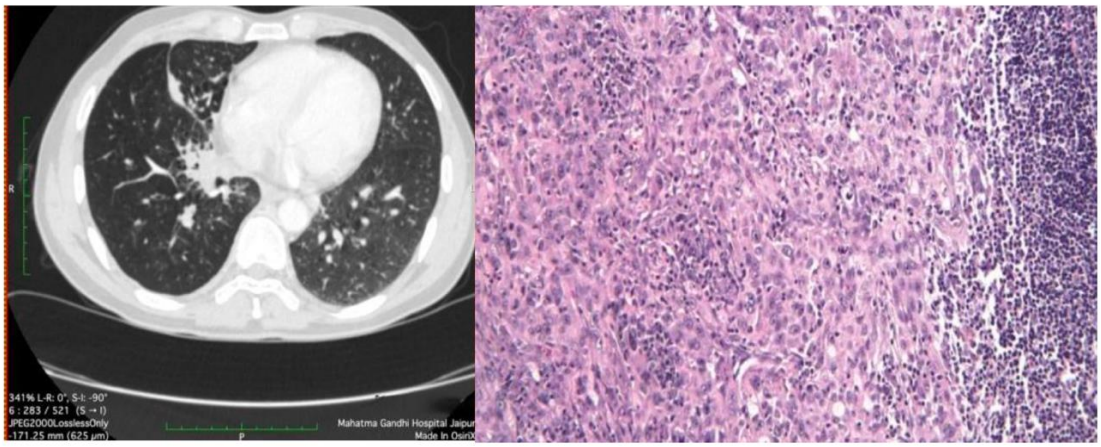

Figure 2. shows heterogeneously enhancing mass lesion is seen in perihilar region of right lung involving the middle and lower lobes . It causes obstruction of right middle lobe bronchus and narrowing of lower lobe bronchus with associated atelectasis in peripheral aspect.

Table 4. Association of smoking status, lesion location, and margins with malignancy

Variable	Category	Benign n	Malignant n	Total	p-value
Smoking status	Non-smoker	11	7	18	0.0004
	Smoker	0	17	17	
Lesion location	Central	0	14	14	0.003
	Peripheral	11	10	21	
Margin type	Smooth	11	0	11	<0.0001
	Lobulated	0	7	7	
	Spiculated	0	17	17	

Among MDCT features, contrast enhancement and lymphadenopathy were present in all malignant lesions and absent in all benign lesions, showing a highly significant association with malignancy ($p < 0.0001$ for both). Necrosis was present in 17 malignant lesions and absent in all benign lesions ($p = 0.0004$). Calcification was observed only in benign lesions and was absent in all malignant lesions, showing a highly significant association with benign etiology ($p < 0.0001$). Metastasis was found only among malignant lesions, being present in 14 malignant cases ($p = 0.003$).

Table 5. Association of key MDCT features with malignancy

MDCT feature	Category	Benign n	Malignant n	Total	p-value
Enhancement	Absent	11	0	11	<0.0001
	Present	0	24	24	
Necrosis	Absent	11	7	18	0.0004
	Present	0	17	17	
Calcification	Present	11	0	11	<0.0001
	Absent	0	24	24	
Lymphadenopathy	Absent	11	0	11	<0.0001
	Present	0	24	24	
Metastasis	Absent	11	10	21	0.003
	Present	0	14	14	

MDCT diagnosis showed complete concordance with histopathological diagnosis. All 24 histopathologically malignant cases were correctly diagnosed as malignant on MDCT, and all 11 benign cases were correctly diagnosed as benign. There were no false-positive or false-negative cases. Accordingly, MDCT showed 100% sensitivity, 100% specificity, 100% positive predictive value, 100% negative predictive value, and 100% diagnostic accuracy for differentiating benign and malignant lung masses in this study.

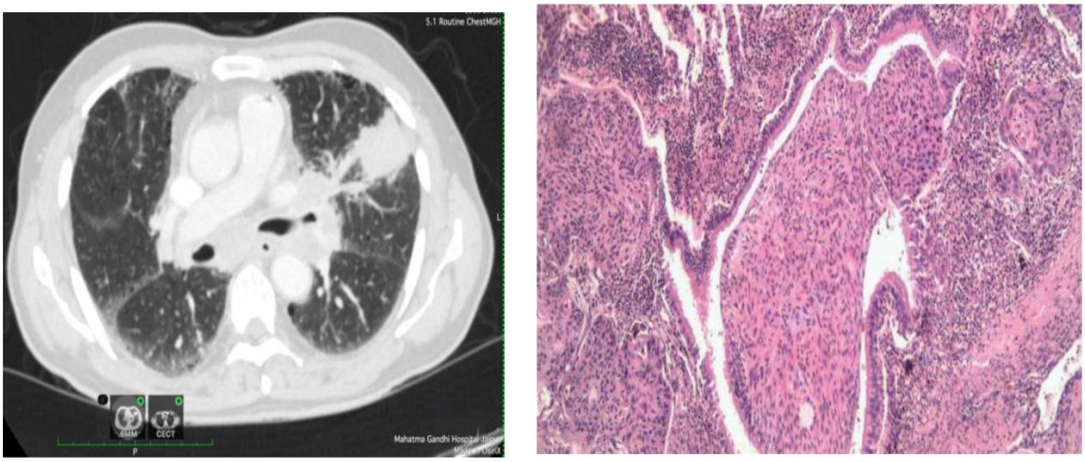

Figure 3. shows A well-defined soft tissue lesion with spiculated margins is noted in the anterior segment closely abutting the adjacent pleura . Mild adjacent pleural thickening is seen. Abrupt cut off of a segmental branch of left upper lobe bronchus is seen- suggestive ofendobronchial obstruction.

Table 6. Diagnostic performance of MDCT using histopathology as gold standard

MDCT diagnosis	Histopathology malignant	Histopathology benign	Total
MDCT malignant	24	0	24
MDCT benign	0	11	11
Total	24	11	35

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DISCUSSION

In the present study, MDCT showed excellent diagnostic utility in the evaluation of lung masses, with histopathology used as the reference standard. Malignant lesions constituted the majority of cases, accounting for 24/35 cases (68.6%), while benign lesions accounted for 11/35 cases (31.4%). This predominance of malignancy is expected in a tertiary-care setting where patients are often referred after initial clinical or radiographic suspicion of serious pulmonary pathology. Similar observations have been reported by Khanduri et al., Biswas et al., and Gupta et al., who also found a high proportion of malignant lesions among patients undergoing CT evaluation for lung masses[11,12,13]. The finding is clinically important because a pulmonary mass, by definition larger than 3 cm, carries a higher probability of malignancy than a smaller pulmonary nodule[1].

The demographic profile showed male predominance, and smoking showed a strong association with malignancy. All smokers in the present study had malignant lesions. This finding is consistent with the established role of tobacco exposure in lung carcinogenesis, where carcinogens in tobacco smoke induce molecular alterations leading to malignant transformation[3]. Noronha et al. also highlighted the continuing importance of smoking in Indian lung cancer epidemiology, although the proportion of non-smoker lung cancer is increasing in India[4]. Therefore, while smoking remains a major risk factor, malignancy cannot be excluded in non-smokers, particularly in the current era of increasing adenocarcinoma and molecularly driven lung cancers.

Histopathologically, adenocarcinoma was the most common malignant subtype, followed by squamous cell carcinoma. This pattern agrees with the global shift in lung cancer histology, with adenocarcinoma now being the most frequent subtype in many populations[5]. Gupta et al. also reported adenocarcinoma as the predominant subtype among malignant lung masses[13].Among benign lesions, tubercular granuloma was the most common diagnosis, reflecting the Indian clinical context where tuberculosis remains an important mimic of malignancy. Jeong and Lee emphasized that pulmonary tuberculosis may present as mass-like lesions with irregular margins, necrosis, and lymphadenopathy, thereby creating diagnostic overlap with lung cancer[14]. This highlights the importance of radiological–pathological correlation in tuberculosis-endemic regions.

Peripheral lesions were more common overall, but central location showed a significant association with malignancy. This may be explained by the inclusion of central bronchogenic carcinomas, particularly squamous cell carcinoma, which commonly presents as a central mass with bronchial obstruction, collapse, or post-obstructive changes. At the same time, adenocarcinoma frequently occurs in the peripheral lung, which may explain the overall predominance of peripheral lesions in the study[5,15]. Thus, lesion location is useful but should not be interpreted alone; it must be assessed along with margin, enhancement, necrosis, airway involvement, nodal disease, and metastatic features.

Margin characteristics were among the strongest predictors of malignancy. In the present study, spiculated and lobulated margins were significantly associated with malignant lesions, whereas smooth margins were seen in benign lesions. Spiculation represents tumour infiltration into surrounding lung parenchyma and desmoplastic reaction, making it one of the most reliable CT indicators of malignancy. Swensen et al. identified spiculation as a major predictor of malignancy in pulmonary nodules, and Khanduri et al. similarly found spiculated margins to be significantly associated with malignant lung masses[11, 16]. However, margin irregularity is not completely specific, as inflammatory lesions such as organizing pneumonia and tuberculosis can also mimic malignant morphology[14,17].

Contrast enhancement was another important discriminator. All malignant lesions in this study showed enhancement, while benign lesions did not show significant enhancement. This finding supports the concept that malignant tumours show increased vascularity due to neoangiogenesis. Swensen et al. demonstrated the diagnostic value of contrast enhancement in pulmonary nodules, and dynamic contrast-enhanced CT studies have further shown higher perfusion parameters in malignant lesions[7,18]. Shukla et al. also reported that perfusion characteristics on dynamic contrast-enhanced CT were significantly different between benign and malignant lung masses, supporting the functional role of CT beyond morphology[19]. Nevertheless, enhancement must be interpreted cautiously because infective and inflammatory lesions may also enhance.

Necrosis was significantly associated with malignancy in the present study. Central necrosis in a lung mass generally reflects rapid tumour growth outstripping vascular supply, and it is commonly seen in aggressive malignancies, including squamous cell carcinoma. Woodring and Fried described the value of cavitary wall characteristics and internal morphology in differentiating malignant from benign cavitary lung lesions[20]. However, necrosis may also occur in tuberculosis and abscesses,

particularly in India, and therefore should be interpreted with clinical and laboratory correlation[8, 14].

Calcification was strongly associated with benign lesions in the present study. All calcified lesions were benign, while malignant lesions did not show calcification. This agrees with classical radiological principles that central, laminated, diffuse, and popcorn calcification patterns favour benignity, particularly granulomas and hamartomas[21, 22]. Siegelman et al. demonstrated that fat attenuation and popcorn calcification are characteristic CT features of pulmonary hamartoma[22]. However, rare malignant lesions may show eccentric or stippled calcification; therefore, the pattern of calcification is more important than the mere presence of calcium.

Lymphadenopathy and metastasis showed significant associations with malignancy. In the present study, lymphadenopathy was observed in malignant cases and was absent in benign cases. CT is central to the evaluation of hilar and mediastinal lymph nodes, although nodal size alone is not always sufficient to prove metastasis. Erasmus et al. emphasized the value of CT in staging lung cancer, including assessment of lymph nodes, mediastinal invasion, and distant spread[9]. Detterbeck et al. also noted that nodal morphology, necrosis, and heterogeneity may be more informative than size alone[23]. The association of metastasis exclusively with malignant lesions further supports the role of MDCT in comprehensive staging and management planning[9, 24].

The most important finding of the present study was the complete concordance between MDCT diagnosis and histopathology. MDCT achieved 100% sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy for differentiating benign and malignant lung masses. This is higher than many earlier studies, including Khanduri et al., Gupta et al., and Biswas et al., who reported high but not perfect diagnostic concordance[11,13]. The excellent performance in the present study may be due to clear radiological differentiation, experienced interpretation, and limited numbers of borderline or indeterminate lesions. Therefore, although the findings support MDCT as a highly reliable modality, the 100% accuracy should be interpreted cautiously because of the small sample size.

Limitations: The present study had certain limitations. First, it was a single-centre hospital-based study with a relatively small sample size of 35 patients; therefore, the findings may not be fully generalizable to the wider population. Second, only patients who underwent both MDCT and histopathological examination were included, which may have introduced selection bias toward clinically suspicious or advanced lesions. Third, although MDCT showed excellent diagnostic performance in this study, the 100% sensitivity and specificity should be interpreted cautiously because of the limited sample size and clear radiological differentiation of included cases. Fourth, advanced imaging techniques such as PET-CT, diffusion-weighted MRI, dual-energy CT, perfusion CT, and radiomics-based analysis were not included. Finally, long-term follow-up and survival outcomes were not assessed, so correlation with prognosis and treatment response could not be evaluated.

Overall, this study reinforces the central role of MDCT in the evaluation of lung masses. MDCT provides detailed information regarding lesion morphology, enhancement, necrosis, calcification, airway involvement, lymphadenopathy, and metastatic spread. It helps differentiate benign from malignant lesions, guides biopsy site selection, assists staging, and supports clinical decision-making. However, histopathological confirmation remains essential, especially in regions where tuberculosis and inflammatory lesions frequently mimic malignancy. The study therefore supports the use of MDCT as a primary imaging modality for lung mass evaluation, with final diagnosis established through radiological–pathological correlation.

CONCLUSION

MDCT proved to be a highly useful imaging modality for the evaluation and characterization of lung masses. In the present study, MDCT findings showed complete concordance with histopathological diagnosis in differentiating benign and malignant lesions. Features such as spiculated or lobulated margins, contrast enhancement, necrosis, lymphadenopathy, central location, and metastasis were strongly associated with malignancy, whereas smooth margins and calcification favoured benign etiology. Adenocarcinoma was the most common malignant histological subtype, while tubercular granuloma was the most frequent benign diagnosis. Thus, MDCT provides valuable information regarding lesion morphology, local extension, nodal involvement, and metastatic spread, and plays an important role in guiding biopsy, staging, and clinical management. However, histopathological confirmation remains essential for definitive diagnosis.

Recommendations

MDCT should be used as the primary cross-sectional imaging modality for patients presenting with suspected lung masses, especially when chest radiography is inconclusive or when malignancy is clinically suspected. A structured MDCT reporting format should be followed, including lesion size, location, margins, enhancement, necrosis, calcification, cavitation, airway involvement, pleural/chest wall invasion, lymphadenopathy, and metastasis. In tuberculosis-endemic regions, infective lesions should be carefully differentiated from malignancy using combined clinical, radiological, and histopathological correlation. CT-guided biopsy should be planned based on MDCT findings to target the most representative and viable part of the lesion. Larger multicentric studies with long-term follow-up, PET-CT correlation, perfusion imaging, and

radiomics-based assessment are recommended to further validate the diagnostic accuracy of MDCT and improve non-invasive characterization of lung masses.

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