

Comparison of Diagnostic Yield of Various Bronchoscopic Modalities in Diagnosis of Patients having Central Lung Mass in a Tertiary Care Hospital - An Observational Study

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Abstract

Background: Lung cancer remains a major cause of morbidity and mortality worldwide. Early diagnosis is critical for effective treatment. This study evaluates the demographic profile, clinical presentation, radiological features, bronchoscopic findings, and diagnostic efficacy of various bronchoscopic sampling techniques in detecting central lung mass. **Material and Methods:** A cross-sectional study was conducted in a single tertiary care center on 41 patients diagnosed with central lung masses based on clinical evaluation, radiological imaging, and bronchoscopic assessment. The bronchoscopic techniques included endobronchial biopsy, bronchial wash cytology, brushing cytology, and cell block preparation. The diagnostic yield of each procedure was assessed and compared using standard performance metrics, including sensitivity, specificity, positive and negative predictive values, overall diagnostic accuracy, and receiver operating characteristic (ROC) curves. **Results:** Most patients were aged 61–70 years (mean: 66.02 ± 9.95), with males comprising 65.85%. Common symptoms included dyspnea (82.9%) and cough (75.6%). Radiologically, right lung masses were most common. The right upper lobe mass lesion was the most frequent CT finding (43.9%), and mediastinal lymphadenopathy was present in 63.4%. Endobronchial biopsy had the highest sensitivity (95.1%). Bronchial brushing cytology showed excellent diagnostic accuracy (74.4%) and highest AUC (0.875), followed by cell block (AUC 0.833). Bronchial wash cytology had low sensitivity (37.8%) but perfect specificity. **Conclusion:** Endobronchial biopsy remains the diagnostic gold standard, while brushing cytology and cell block provide high diagnostic yields and can complement biopsy, especially when tissue sampling is limited. A multimodal bronchoscopic approach enhances diagnostic accuracy in central lung mass evaluation.

Keywords: Lung Cancer, Bronchoscopy, Endobronchial Biopsy, Bronchial Brushing Cytology, Diagnostic Yield.

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INTRODUCTION

Lung cancer remains the most common malignancy and the leading cause of cancer-related deaths worldwide, with a particularly high burden in industrialized countries.^[1,2] Contributing factors include smoking, environmental pollution, and improved detection methods.^[1] Prognosis is closely tied to the stage at diagnosis, with five-year survival rates ranging from 80% in stage I to 5% in stage IV.^[3] Early and accurate diagnosis is thus critical. Bronchoscopy plays a pivotal role in evaluating central lung masses, allowing for procedures like bronchial washing, brushing, and biopsy.^[4,5] Cytology is widely used due to its safety and rapid results, and diagnostic accuracy improves when combined with cell block techniques.^[6] However, few studies compare these modalities, especially in the Eastern Indian setting,^[7] highlighting the need for this study.

Department of Respiratory Medicine at a tertiary center in Eastern India, following approval from the Institutional Ethics Committee. The study aimed to evaluate and compare the diagnostic yield of various bronchoscopic modalities in patients presenting with radiologically detected central lung masses.

Study Population and Sampling

Patients aged over 18 years with radiologically confirmed central lung masses admitted to the department were considered for inclusion. Informed consent was obtained from all participants. Exclusion criteria encompassed patients without visible endobronchial lesions during bronchoscopy, those with

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MATERIALS AND METHODS

Study design and setting

This hospital-based descriptive, observational cross-sectional study was conducted over 18 months in the

massive hemoptysis, hemodynamic instability, emergency conditions precluding biopsy, or refusal to undergo fiberoptic bronchoscopy (FOB).

Sample size: Data collection occurred on randomly selected three days per week, ensuring variability to minimize selection bias. Over the study period, 65 patients met the inclusion criteria, and after the exclusion of 24 patients, 41 patients were enrolled in the study.

Definitions: A central lung mass was defined as a tumor located in the trachea, main stem, or segmental bronchi. Peripheral lung masses were characterized as tumors situated beyond the subsegmental bronchi or within 3 cm of the pleura.

Data Collection and Procedures

Comprehensive clinical evaluations, including detailed history and physical examinations, were performed. Radiological assessments involved chest X-rays (posteroanterior view) and contrast-enhanced computed tomography (CECT) of the thorax using the GE Healthcare Optima CT machine.

FOB was conducted using the Ambu® aScope™ 4 Broncho to identify visible endobronchial lesions. Upon detection, bronchial washings, brushings, and biopsies were obtained. Samples were processed for cytological analysis, cell block preparation, and histopathological examination (HPE).

Variables: Independent variables included patient demographics (age, gender, smoking history, occupation), clinical presentations (symptoms, comorbidities), and radiological findings. The primary dependent variables were the diagnostic yields of endobronchial biopsy (considered the gold standard), bronchial washing cytology, bronchial washing cell block, and bronchial brushing cytology.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS statistical software (Version 26.0, IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test assessed data normality. Categorical variables were expressed as percentages or proportions, while continuous variables were presented as means and standard deviations or medians with interquartile ranges, depending on distribution.

Diagnostic performance metrics like sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated for each bronchoscopic modality, using endobronchial biopsy results as the reference standard. Receiver operating characteristic (ROC) curves were generated to evaluate diagnostic efficacy, with areas under the curve (AUC) reported alongside 95% confidence intervals. Comparisons of proportions utilized the Chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

Ethics: Approval for the study was obtained from the Institutional Ethics Committee vide no. CMSDH/IEC/56/05-2023 dated 27.05.2023. Written informed consent was taken from all participants in accordance with the Declaration of Helsinki (1975, revised 2000). Participation was voluntary, with full disclosure of study objectives and procedures. Patients retained the right to withdraw at any point without affecting their medical

care. Confidentiality and data protection were strictly maintained throughout the study.

RESULTS

The present study included a total of 41 patients diagnosed with a central lung mass based on clinical and radiological evaluation. The detailed patient recruitment is given in a flowchart form in [Figure 1].

Demographics: The age of the patients ranged from 30 to 90 years, with a mean age of 66.0 ± 9.95 years. The majority of patients (48.8%) were in the 61–70 years age group, followed by 24.4% in the 71–80 years group. This indicates that central lung masses were more prevalent among elderly individuals.

Males comprised the majority of study participants, accounting for 65.85% (n = 27) of the study population, while females constituted 34.15% (n = 14). Most of the female patients were homemakers, whereas male patients had a diverse occupational background. The most common occupation among males was factory work (17.07%), followed by business-related activities such as vending or shopkeeping (14.63%). Farmers constituted 7.32% of the cohort, and 26.83% of patients were engaged in other occupations, including teaching and masonry. [Table 1]

Personal history and symptoms: Addiction history revealed that 25 patients (60.98%) had a history of smoking, and 6 (14.63%) consumed alcohol regularly. The majority of smokers were male, aligning with the occupational profile and overall demographic pattern of the study population.

The most common presenting symptom was shortness of breath, reported by 82.9% (n = 34) of patients. Cough was the second most prevalent symptom, observed in 75.6% (n = 31), followed by anorexia and/or weight loss in 68.3% (n = 28), and chest pain in 63.4% (n = 26). Hemoptysis was noted in 13 patients (31.7%), while fever was present in 8 patients (19.5%). These findings suggest that respiratory distress and constitutional symptoms were predominant among patients with central lung mass. [Table 1]

Blood investigations and radiology: Blood investigations showed a median hemoglobin level of 10.5 g/dL (IQR: 9.8–11.3), reflecting a tendency toward anemia in this group. The median total leukocyte count was 8,980/cumm (IQR: 7,350–11,100), while median blood urea and serum creatinine levels were 34 mg/dL (IQR: 28.5–39.5) and 0.9 mg/dL (IQR: 0.8–1.1), respectively. The median INR was 0.9 (IQR: 0.85–1.0). Due to the presence of outliers and non-normal distribution of values, the data were summarized using medians and interquartile ranges.

Chest X-ray findings revealed that in 71% (n = 29) of patients, the lung mass was located on the right side, while in 29% (n = 12), it was on the left. Associated findings included consolidation or collapse in 65.9% (n = 27) of patients and pleural effusion in 31.7% (n = 13). These features were consistent with large obstructive or invasive central lesions, often causing secondary parenchymal changes.

On contrast-enhanced computed tomography (CECT) of the thorax, the most common site of the lung mass was the right upper lobe (43.9%, n = 18), followed by the right lower lobe (26.8%, n = 11), left upper lobe (24.4%, n = 10), and left lower lobe (4.9%, n = 2). Associated findings on CECT thorax

included consolidation or collapse in 65.9% (n = 27), mediastinal lymphadenopathy in 63.4% (n = 26), and pleural effusion in 31.7% (n = 13). These imaging features supported the diagnosis of centrally located malignant lesions with significant locoregional involvement. (Table 2)

Bronchoscopy and histopathology findings: On fibre-optic bronchoscopy (FOB), the most common location of endobronchial lesions was the main bronchus (39.0%, n = 16), followed by the intermediate bronchus (31.7%, n = 13). The upper and lower lobe bronchi were involved in 17.0% (n = 7) and 9.8% (n = 4) of cases, respectively. In one patient (2.4%), bilateral endobronchial growth was noted. The most frequent appearance of the lesion was infiltrative growth (65.9%, n = 27), followed by proliferative growth (34.1%, n = 14), and one patient had mucosal irregularity only (2.4%).

Histopathological analysis revealed that squamous cell carcinoma was the most common malignancy, diagnosed in 14 patients (34.2%). Adenocarcinoma accounted for 21.9% (n = 9), while small cell carcinoma was detected in 14.6% (n = 6). There was no significant association between smoking status and histological type of cancer in our study (P 0.862), however squamous cell carcinoma was found more in smokers than non-smokers (71.4% vs 28.6%, P 0.501). [Table 3]

Diagnostic yield of various bronchoscopic techniques

Regarding the diagnostic yield of bronchoscopic sampling techniques, endobronchial biopsy was the most effective, yielding a definitive diagnosis in 39 of the 41 patients (95.1%). The diagnostic performance of various bronchoscopic cytological techniques was evaluated through cross-tabulation with biopsy-proven histopathological findings as the gold standard and receiver operating characteristic (ROC) analysis. Bronchial washing cytology demonstrated a sensitivity of 37.8%, specificity of 100%, positive predictive value (PPV) of 100%, and negative predictive value (NPV) of 8%, with an overall diagnostic accuracy of 41%. In contrast, bronchial washing cell block cytology, after excluding one inadequate sample, showed markedly improved sensitivity at 66.7%, maintained a specificity and PPV of 100%, but had a low NPV of 14% and an overall accuracy of 68.4%. Bronchial brushing cytology had the highest sensitivity among the three techniques at 72.9%, with 100% specificity and PPV, an NPV of 16%, and overall diagnostic accuracy of 74.4%. ROC curve analysis corroborated these findings. The area under the curve (AUC) for bronchial wash cytology was 0.694 (95% CI: 0.420–0.969; P 0.165), indicating modest performance without statistical significance. In comparison, the AUC for cell block cytology was 0.833 (95% CI: 0.663–1.000; P 0.000), and for bronchial brushing cytology it was highest at 0.875 (95% CI: 0.737–1.000; P 0.000), both showing statistically significant and strong discriminatory ability. These results underscore the superior diagnostic utility of brushing and cell block cytology over wash cytology alone in evaluating endobronchial lesions. [Table 4 and Figure 2]

Radiological and bronchoscopic images are given in [Supplementary Figures 1-6].

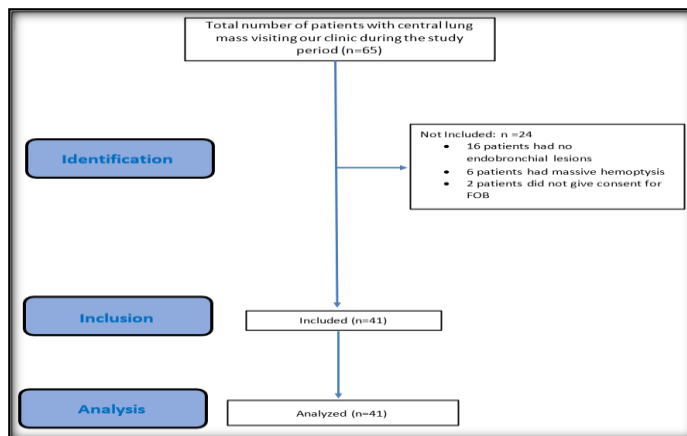


Figure 1: STROBE Flow Chart: Strengthening the Reporting of Observational Studies in Epidemiology: Abbreviations: FOB – Fiber optic bronchoscopy.

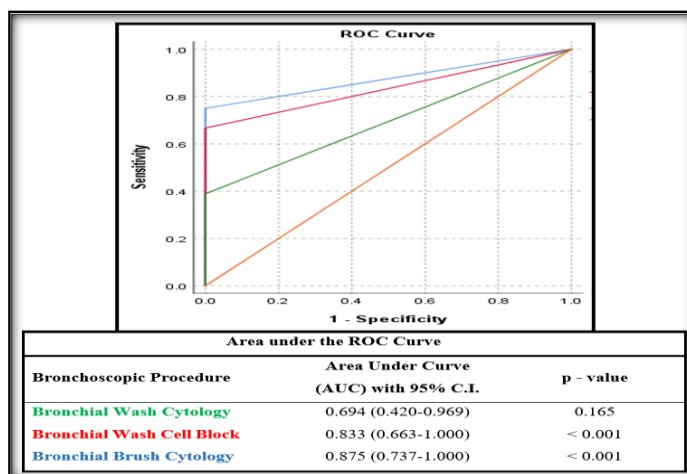
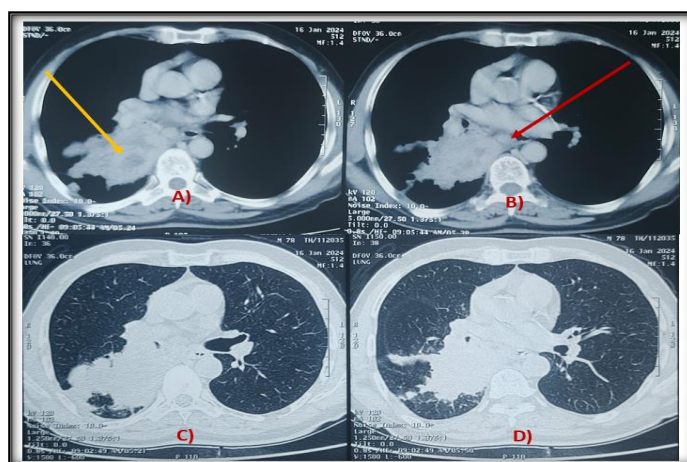
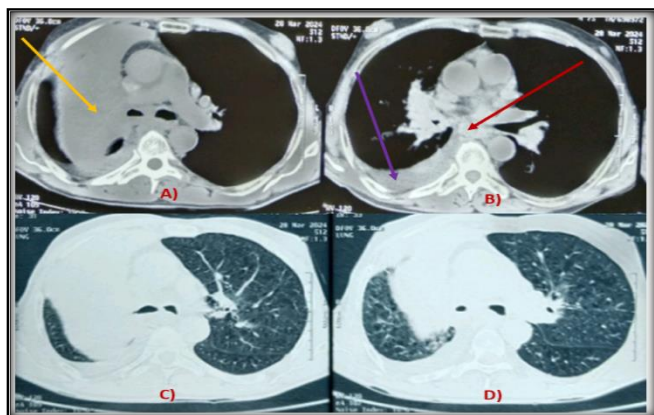


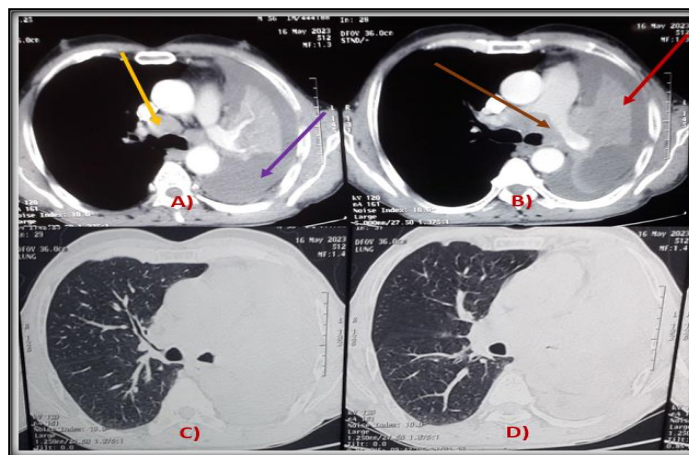
Figure 2: Diagram showing ROC curve for bronchial washing cytology (Green), bronchial washing cell block (Red) and bronchial brushing cytology (Blue). Table below showing area under ROC curve with 95% confidence interval and their respective p-values (n = 39).



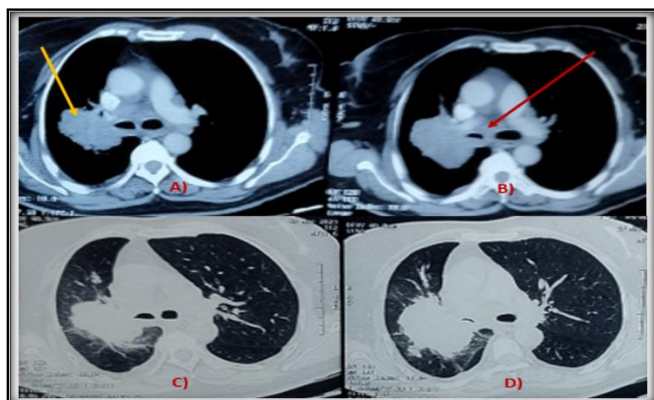
Supplementary Figure 1: CECT Thorax scan sections [mediastinal (A, B) and parenchymal (C, D) window] showing right upper lobe lung mass (yellow arrow) almost completely obstructing the right intermediate bronchus with mediastinal lymphadenopathy (dark red arrow).



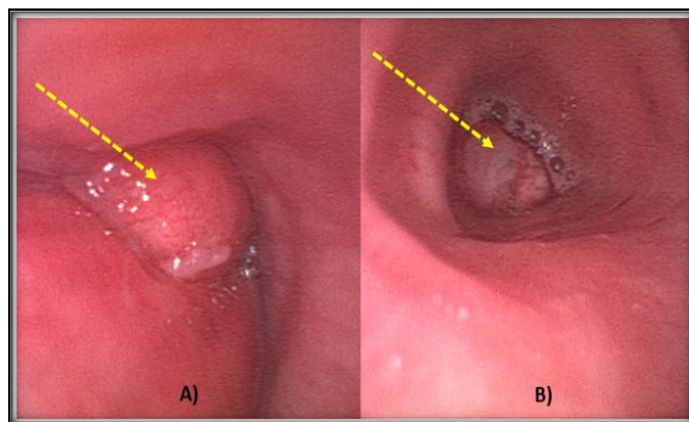
Supplementary Figure 2: CECT Thorax scan sections [mediastinal (A, B) and parenchymal (C, D) window] showing right upper and lower lobe lung mass right main bronchus (yellow arrow) concentric narrowing with right sided pleural effusion (purple arrow) and mediastinal lymphadenopathy (red arrow).



Supplementary Figure 4: CECT Thorax scan sections [mediastinal (A, B) and parenchymal (C, D) window] showing left upper lobe lung mass (brown arrow) almost completely obstructing the left main bronchus with left sided lung collapse (red arrow), pleural effusion (purple arrow) and mediastinal lymphadenopathy (yellow arrow).



Supplementary Figure 3: CECT Thorax scan sections [mediastinal (A, B) and parenchymal (C, D) window] showing right hilar lung mass (yellow arrow) partially obstructing the right main bronchus with right pleural thickening and mediastinal lymphadenopathy (red arrow).



Supplementary Figure 5: Pictograph A and B showing exophytic (proliferative) growths (marked by dashed yellow arrows) in two separate patients as seen during fiber optic bronchoscopy.

Table 1: Baseline demographic and clinical parameters of the study population (n = 41)

Baseline Parameters	n (%)
Age (Mean (SD), years)	66.0 (9.95)
Gender	
Male	27 (65.8)
Female	14 (34.2)
Occupation	
Homemaker	14 (34.2)
Factory worker	7 (17.1)
Farmer	7 (7.3)
Business (Vendors and Shopkeepers)	6 (14.6)
Others (teachers, carpenter, plumber, mason)	11 (26.8)
Addiction	
Smoking	25 (61.0)
Alcohol	6 (14.6)
Symptoms	
Cough	31 (75.6)
Breathlessness	34 (82.9)
Chest pain	26 (63.4)
Hemoptysis	13 (31.7)
Anorexia	28 (68.3)
Fever	8 (19.5)

SD – Standard Deviation

Table 2: Blood Investigations and radiology parameters in the study population (n = 41)

Blood and Radiology Parameters	n (%)
Blood investigations (Median (IQR))	
Hemoglobin (gm/dL)	10.5 (9.8-11.3)
TLC (/cumm)	8980.0 (7350.0-11100.0)
Urea (mg/dL)	34.0 (28.5-39.5)
Creatinine (mg/dL)	0.9 (0.8-1.1)
INR	0.9 (0.8-1.0)
Chest X-ray findings	
Right-sided Mass	29 (71.0)
Left-sided Mass	12 (29.0)
Collapse	27 (65.9)
Pleural Effusion	13 (31.7)
CECT Thorax Findings	
LUL Mass	10 (24.4)
LLL Mass	2 (4.9)
RUL Mass	18 (43.9)
RLL Mass	11 (26.8)
Collapse	27 (65.9)
Pleural Effusion	13 (31.7)
Mediastinal LN	26 (63.4)

IQR – Interquartile Range; LUL – Left upper lobe; LLL – Left lower lobe; RUL – Right upper lobe; RLL – Right lower lobe; LN - Lymphadenopathy

Table 3: Bronchoscopy and Histopathology findings of study population (n = 41)

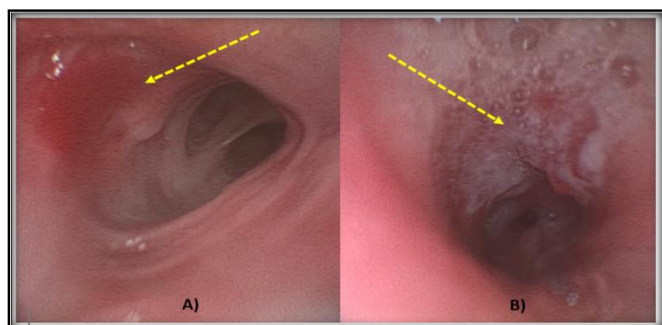
Bronchoscopy and Histology Parameters	n (%)
Endobronchial location	
Main bronchus	16 (39.0)
Upper lobe bronchus	7 (17.0)
Intermediate bronchus	13 (31.7)
Lower lobe bronchus	4 (9.8)
Bilateral	1 (2.4)
Nature of lesion/ growth	
Proliferative	14 (34.1)
Infiltrative	27 (65.9)
Mucosal irregularity only	1 (2.4)
Histopathology	
Adenocarcinoma	9 (22.0)
Squamous cell carcinoma	14 (34.2)
Small cell carcinoma	6 (14.6)
Poorly differentiated carcinoma	7 (17.1)
Inflammatory lesion	2 (4.9)
Metastatic carcinomatous deposit	1 (2.4)
Round cell neoplasm (benign)	1 (2.4)
Granulomatous lesion*	1 (2.4)

Abbreviations: NIL; * - Diagnosed as endobronchial tuberculosis

Table 4: Diagnostic yield of various bronchoscopic modalities in the study population (n = 41)

Modality	Sensitivity	Specificity	PPV	NPV	Yield
Endobronchial Biopsy*	-	-	-	-	95.1%
Bronchial Wash cytology	37.8%	100%	100%	8.0%	41.0%
Bronchial Wash cell block	66.7%	100%	100%	14.0%	68.4%
Bronchial Brush cytology	72.9%	100%	100%	16.0%	74.4%

* - Endobronchial biopsy is the gold standard so only yield has been reported, PPV – Positive predictive value, NPV – Negative predictive value



Supplementary Figure 6: Pictograph A and B showing infiltrative growths (marked by dashed yellow arrows) in two separate patients as seen during bronchoscopy.

DISCUSSION

This study assessed the diagnostic performance of various bronchoscopic modalities (bronchial wash cytology, bronchial wash cell block, and bronchial brush cytology) against endobronchial biopsy (EBB), the gold standard, in detecting central lung masses. While all modalities showed high specificity and positive predictive value (PPV), sensitivity and negative predictive value (NPV) varied. Bronchial brushing emerged as the most effective technique, with the highest sensitivity (72.9%) and diagnostic accuracy (74.4%), followed by bronchial wash cell block (66.7% sensitivity, 68.4% accuracy). Bronchial wash cytology was the least effective (37.8% sensitivity, 41.2% accuracy). ROC analysis supported

these findings, with bronchial brushing showing the highest AUC (0.875), indicating excellent discriminatory ability. The majority of patients were aged 61–70 years (48.8%), with a mean age of 66.02 ± 9.95 years, consistent with reports by Kumar V et al,^[8] where most lung cancer cases occurred in the sixth and seventh decades of life, with a reported mean age of 54.71 years. Males comprised 66% of the study population, in line with prior studies linking higher lung cancer prevalence to smoking and occupational exposures. Zhu J et al,^[9] reported a sex distribution of 83% male and 17% female, while Atanasov Mitev M et al,^[10] reported 74% males and 26% females. However, 34% were females, possibly due to biomass fuel exposure, as noted by Behera D et al,^[11] who concluded that biomass fuel exposure is an important risk factor in the causation of lung cancer among women in addition of exposure to tobacco smoke.

Factory workers (16.7%) and farmers (7.1%) represented high-risk occupational groups, with farmers at risk from silica exposure in crops, as reported by Amre DK et al,^[12] He reported that lung cancer in sugarcane farmers in India had an increased risk of lung cancer. Exposure to fibers of biogenic amorphous silica (BAS) formed from silica absorbed from the soil and deposited in the leaves of the sugar cane crop or crystalline silica formed because of conversion of BAS to cristobalite at high temperatures may account for the increased risks of lung cancer among sugar cane farmers.

Addiction patterns revealed that 61% of patients had a history of smoking, yet 39% were non-smokers, indicating other contributing factors like genetic predisposition or environmental exposures. Zhou F et al,^[13] also highlighted an increasing incidence of lung cancer among never-smokers, particularly in Asia.

Common presenting symptoms included shortness of breath (82.9%), cough (75.6%), weight loss (68.3%), chest pain (63.4%), and hemoptysis (31.7%), similar to findings by Mohan A et al,^[14] Blood parameters showed mild anemia (median Hb: 10.5 g/dL), normal TLC, and slightly elevated urea, suggesting chronic disease or malnutrition. Huang Y et al,^[15] found that anemia was associated with poor prognosis in lung cancer.

Radiologically, 71% had right-sided masses, predominantly in the right upper lobe (44%), consistent with a study by Nilssen Y et al,^[16] who upon analyzing 10,849 lung cancer patients reported that the right upper lobe accounted for 31.2% of tumors, despite comprising only 17.6% of lung volume, indicating a higher predilection for tumor development in this lobe. Associated findings in our study included consolidation/collapse (65.9%), pleural effusion (31.7%), and mediastinal lymphadenopathy (63.4%), suggesting advanced disease. A study by Saha et al,^[17] reported the most commonly presenting xray features as collapse (38.78%) followed by consolidations (28.57%). Chalian H et al,^[18] found mediastinal lymphadenopathy (MLN) was associated with an increased incidence of lung cancer, with 17.1% of participants with MLN diagnosed with lung cancer compared to 7.1% without MLN supporting our findings.

Bronchoscopic evaluation showed that the main bronchus was most commonly involved (39%), followed by the intermediate bronchus (31.7%), consistent with findings from Elhidsi M et al,^[19] who reported intermediate bronchus as the second most common site of involvement (31.7%) followed by upper lobe bronchus (17%) and lower lobe bronchus (9.8%). Infiltrative growth patterns were seen in 65.9%, indicating aggressive disease, corroborating results from Biciuşcă V et al,^[20] who reported that the most common macroscopic appearance of lung tumors was infiltrative, observed in 58.33% of cases, followed by exophytic (mass) endobronchial lesions in 22.22%, and mixed forms in 19.44%.

Histological Subtypes and Diagnostic Modalities in Central Lung Masses: In this cohort of 41 patients with central lung masses, Non-Small Cell Lung Cancer (NSCLC) was the most common histology, accounting for 23 cases (56.1%). Among NSCLC, squamous cell carcinoma (SCC) was most prevalent (14 cases, 34.1%), followed by adenocarcinoma (ADC) in 9 cases (22%). SCC is strongly associated with smoking and typically presents as central masses, which aligns with the high smoker proportion (61%) in this study. NSCLC is the most prevalent form of lung cancer, accounting for approximately 80-85% of all lung cancer cases,^[21] as per lung cancer statistics of the American Cancer Society recent data. A study by Sung YE et al,^[22] comparing peripheral and central lung SCCs found that central SCCs constituted 43.2% of cases, reinforcing the association of SCC with central airway involvement. Poorly differentiated carcinoma was seen in 7 cases (17%), and small cell lung cancer (SCLC) in 6 cases (15%), consistent with global prevalence data wherein the prevalence of SCLC is also around 15%.^[23-26]

Endobronchial biopsy (EBB) demonstrated high sensitivity (95.12%) and diagnostic yield in cases with visible endobronchial abnormalities, aligning with findings from Kakodkar et al,^[27] and Ghazarian et al,^[28] who reported a yield of 94% and 100% respectively. In contrast, bronchial washing cytology showed low sensitivity (37.83%) but high specificity and PPV (100%), with a diagnostic accuracy of 41%. Cell block preparation improved sensitivity to 66.7% and accuracy to 68.4%, similar to studies by Kakodkar et al,^[29] (44.23%) and Collins et al,^[30] (61.1%) though NPV remained low (14%). Bronchial brushing cytology had the highest sensitivity (72.9%) among cytologic techniques, with an accuracy of 74.35%, suggesting its superior diagnostic potential. This was consistent with studies by Chowdhury et al,^[31] and Khandelwal et al,^[32] who reported a yield of 80.9% and 70% respectively and showed the importance of adding bronchial brush cytology to increase the overall diagnostic yield.

While cytologic methods offer high specificity and PPV, their limited sensitivity and low NPV highlight the importance of combining multiple modalities. EBB remains the most reliable first-line diagnostic tool for visible central lesions.

This study compares the diagnostic performance of bronchoscopic techniques—bronchial wash cytology, cell block, and brush cytology—against endobronchial biopsy (HPE) in evaluating central lung masses. Endobronchial biopsy remains the gold standard with >95% sensitivity, specificity, and diagnostic accuracy. Among cytology-based methods, bronchial brush cytology demonstrated the highest diagnostic

accuracy (74.4%) and excellent discriminatory power (AUC = 0.875), supported by a statistically significant p-value (P 0.000). This suggests strong reliability and clinical utility, especially when biopsy is not feasible.

Bronchial wash cell block showed good diagnostic ability (AUC = 0.833), with a sensitivity of 66.7% and 100% specificity, making it a valuable adjunctive test. Bronchial wash cytology, on the other hand, showed moderate and inconsistent performance (sensitivity = 37.8%, AUC = 0.694), limiting its utility as a standalone test. While its specificity and positive predictive value were 100%, the very low negative predictive value (8%) reflects a high false-negative rate.

These findings highlight the utility of combining multiple bronchoscopic sampling techniques to optimize diagnostic yield. The integration of brushing and cell block analysis may enhance sensitivity and reduce the need for repeated or more invasive procedures. Endobronchial biopsy should remain a part of the diagnostic strategy whenever feasible.

Strengths and Limitations

This study has several strengths, including a comprehensive comparative evaluation of commonly used bronchoscopic techniques and the use of ROC curve analysis for objective assessment. However, it also has limitations. The relatively small sample size limits the statistical power and generalizability of the results. Being hospital-based, the study is susceptible to selection bias, as it includes only symptomatic patients. Other limitations include the lack of interobserver variability analysis in cytology interpretation, absence of molecular profiling, and the non-standardization of operator technique and sample adequacy—all of which could influence diagnostic outcomes.

CONCLUSION

In conclusion, bronchial brush cytology stands out as the most reliable cytological method for diagnosing central lung masses, particularly when used in combination with cell block analysis. Despite the utility of these less invasive techniques, endobronchial biopsy remains the cornerstone of diagnosis. Future research should focus on larger prospective studies with standardized protocols, explore the integration of molecular and immunohistochemical analyses, and investigate the role of artificial intelligence to further improve diagnostic precision.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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