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# DIAGNOSTIC ACCURACY OF CYTOLOGY IN BRONCHOAL VEOLAR LAVAGE FOR THE DIAGNOSIS OF LUNG CARCINOMA BY TAKING HISTOPATHOLOGY AS GOLD STANDARD IN PATIENTS PRESENTING WITH SUSPECTED PULMONARY NODULE ON CT-SCAN IN TERTIARY CARE HOSPITAL

**Dr. Imran Ali[1*], Dr. Kashaf Memon[2], Dr. Ali Waliullah[3], Dr. Zaheer Akhtar[4], Dr. Gohar Fatima[5], Dr. Ayesha Akhtar[6]**

[1*]Gulab Devi Hospital, Lahore Resident Trainee MBBS, FCPS (Trainee)
imranalikalwar42@gmail.com
[2]Liaquat National Hospital, Karachi Resident Trainee MBBS, FCPS (Trainee)
kashaf90210@hotmail.com
[3]Ghulam Mohammad Mahar Medical College Hospital, Sukkur Consultant MBBS, FCPS
aliwaliullahabbasi@gmail.com
[4]Gulab Devi Hospital, Lahore Professor MBBS, FCPS drzaheerakhtar@yahoo.com
[5]Liaquat National Hospital, Karachi Resident Trainee MBBS, FCPS (Trainee)
goharfatima@live.com
[6]Dr. Ziauddin Hospital, Karachi Resident Trainee MBBS, FCPS (Trainee) aysh92@live.com

**Corresponding author:** Dr. Imran Ali
*Gulab Devi Hospital, Lahore Resident Trainee MBBS, FCPS (Trainee)
imranalikalwar42@gmail.com

## ABSTRACT

**Objective:** To determine the diagnostic accuracy of cytology in bronchoalveolar lavage for the diagnosis of carcinoma lung by taking histopathology as gold standard in patients presenting with suspected pulmonary nodule on CT scan at tertiary care hospital, Lahore.

**Methodology:** A cross-sectional study at Gulab Devi Hospital, Lahore, from February to July 2024 included 65 patients with pulmonary nodules. Using non-probability consecutive sampling, participants aged 20-60 were selected, provided informed consent, and met inclusion criteria. Bronchoalveolar lavage (BAL) findings were compared with histopathology to assess diagnostic accuracy. Data were analyzed with SPSS Version 26, calculating sensitivity, specificity, and other metrics to evaluate BAL's diagnostic performance.

**Results:** The study comprised 65 patients, with a predominant male population (78.5%) and an average age of 42.03 years. The cytology of bronchoalveolar lavage (BAL) demonstrated a sensitivity of 70.59%, a specificity of 91.67%, a positive predictive value of 75%, a negative predictive value of 89.80%, and an overall diagnostic accuracy of 86.15%.

**Conclusion:** Bronchoalveolar lavage (BAL) was found to be a highly specific and overall accurate diagnostic tool for assessing lung carcinoma. BAL cytology significantly enhances precise diagnosis, demonstrating acceptable sensitivity and predictive values among patients. These findings underscore its efficacy as a valuable diagnostic tool in clinical settings.

**Keywords:** Bronchoalveolar lavage, Cytology, Pulmonary Nodule, Lung Carcinoma.

## INTRODUCTION

Lung cancer is among the most challenging health burdens in terms of size, scope, and lethality, primarily due to its strong association with smoking and its significant impact on the global disease burden [1]. The prognosis of lung cancer is directly related to its stage at diagnosis, with 5-year survival rates as low as 5% for late-stage IV cancers but up to 80% when diagnosed early [2]. Therefore, improving early-stage diagnosis is crucial [3].

Primary malignant neoplasms originating in the lung are epithelial cell tumors, which arise largely from four subtypes: small-cell lung cancer (SCLC), adenocarcinoma (AC), squamous cell carcinoma (SCC), and large-cell carcinoma [4]. Bronchoalveolar lavage (BAL) is a powerful diagnostic tool that samples cells and non-cellular material from the lower respiratory tract, reflecting different aspects of lung pathology [5]. It offers a less invasive, non-bronchoscopic method, particularly useful for peripheral lesions or patients at risk of hemorrhage [6]. Compared to conventional, time-consuming histopathological techniques, BAL cytology is a safe, rapid, and cost-effective diagnostic method [7-9].

The importance of BAL in clinical practice is underscored by its ability to enable rapid and precise diagnoses, which are crucial for effective lung cancer management. Bronchial biopsies, especially for peripheral lesions, are challenging and require significant expertise to avoid complications like hemoptysis [10]. Furthermore, biopsies are time-consuming, and there is a demand for quicker diagnostic conclusions [11]. Cytologic methods, on the other hand, are non-invasive, cost-effective, and rapid [12].

This study evaluated the diagnostic accuracy of cytology in bronchoalveolar lavage for detecting lung carcinoma, using histopathology as the gold standard, in patients with suspected pulmonary nodules. The aim was to provide local data demonstrating that reliable diagnostic methods enable early detection and treatment of lung cancer, thereby improving patient survival. The findings confirmed that cytology is a quick and reliable diagnostic procedure, potentially reducing the need for unnecessary biopsies. The results were shared with healthcare institutions, leading to recommendations for early malignancy diagnosis guidelines.

## MATERIAL & METHODS:

A cross-sectional study was conducted from February to July 2024 in the Department of Pulmonology, Gulab Devi Hospital, Lahore. All subjects were given informed consent. A sample size of 65 patients was calculated, based on sensitivity 88.57%, specificity 90.90% and with prevalence of lung carcinoma estimated at 76.4% [22]. A non-probability consecutive sampling was used to recruit eligible participants from a pool of patients that were diagnosed and referred for further assessment after the discovery of pulmonary nodules on CT scans. Only patients with pulmonary nodules meeting the underlying diagnostic criteria, aged between 20 and 60 years regardless of gender were included. Patients with contraindications to bronchoscopy or biopsy, including hypoxia (partial pressure of oxygen [pO2] < 60 mm Hg), bleeding disorders platelet count less than 75 - x109/L transfusion dependent for thrombocytopenic puror coagulation LFT abnormalities international normalized ratio >1 were excluded from the study. The data collection was based on demographic characteristics i.e. age and gender and clinical history. Experienced pulmonologists performed the diagnostic procedure on all enrolled for uniformity and precision in the diagnostic process. The procedure was done under local anesthesia in conjunction with intravenous (i.v.) sedation (midazolam as the agent) if needed to minimize pain and secure cooperation. The diagnosis of lung carcinoma was finally confirmed in bronchoalveolar lavage fluid, through careful microscopic examination. The findings of bronchoalveolar lavage were compared with histopathology findings to assess the diagnostic accuracy. To mitigate potential bias, all specimens were processed and assessed in the

same laboratory. Data analysis was conducted using SPSS Version 26. Descriptive statistics were calculated for quantitative and qualitative variables.

## RESULTS

A sample of 65 patients was included in the study. Most participants were male, comprising 78.5%, while 21.5% were female. The mean age was 42.03 years with a standard deviation of 11.20 years. Age distribution showed that 18.5% were aged 20-30 years, 23.1% were aged 31-40 years, 30.8% were aged 41-50 years, and 27.7% were over 50 years old. In terms of side of involvement, 47.7% had right-sided involvement and 52.3% had left-sided involvement (TABLE 1).

Table 2 provides a comparison between cytology in bronchoalveolar lavage (BAL) and histopathological diagnosis, considered the gold standard, among 65 participants. Of the 17 cases where cytology indicated positivity, 12 were true positives, while 4 were false positives. Conversely, among the 48 cases where cytology indicated negativity, 5 were false negatives, and 44 were true negatives.

Table 3 presents the diagnostic performance metrics of bronchoalveolar lavage (BAL) cytology in detecting lung carcinoma. The sensitivity of BAL cytology, which indicates its accuracy in identifying positive cases, was 70.59%. The specificity, representing its accuracy in identifying negative cases, was 91.67%. The positive predictive value (PPV), showing the proportion of true positive results, was 75.00%, and the negative predictive value (NPV), indicating the proportion of true negative results, was 89.80%.

Table 4 details the diagnostic accuracy of bronchoalveolar lavage (BAL) cytology in detecting lung carcinoma across various variables. Among males, the sensitivity was 71.43%, specificity 89.19%, and overall accuracy 84.31%. In females, sensitivity was 66.67%, specificity 100.0%, and accuracy 92.86%. Age-specific sensitivities ranged from 50.00% to 100.0%, specificities from 80.00% to 100.0%, and accuracies from 75.00% to 95.0%. For side-specific results, sensitivities were 70.00% to 71.43%, specificities 85.71% to 96.30%, and accuracies 80.65% to 91.18%.

**Table 1: Demographic Characteristics of Study Participants (n=65)**

| Variable | n (%) |
|---|---|
| **Gender** | |
| Male | 51 (78.5) |
| Female | 14 (21.5) |
| **Age (Mean ± SD) =** 42.03 ± 11.20 | |
| 20-30 years | 12 (18.5) |
| 31-40 years | 15 (23.1) |
| 41-50 years | 20 (30.8) |
| >50 years | 18 (27.7) |
| **Side of Involvement** | |
| Right | 31 (47.7) |
| Left | 34 (52.3) |

**Table 2: Comparison of Cytology in (BAL) and Histopathological Diagnosis (n=65)**

| Cytology in (BAL) | Histopathology (Gold Standard) | |
|---|---|---|
| | **Positive** | **Negative** |
| **Positive** | True positive<br>12 | False positive<br>4 |
| **Negative** | False negative<br>5 | True negative<br>44 |
| Total | 17 | 48 |
| | | |

| Table 3: Diagnostic Accuracy of Cytology in (BAL) In Detecting Lung Carcinoma | |
|---|---|
| **Diagnostic Variables** | **Cytology in (BAL)** |
| Sensitivity | 70.59% |
| Specificity | 91.67% |
| Positive Predictive Value | 75.00% |
| Negative Predictive Value | 89.80% |
| Diagnostic Accuracy | 86.15% |

| Table 4: Diagnostic Accuracy of Cytology in (BAL) In Detecting Lung Carcinoma among Variables | | | | | |
|---|---|---|---|---|---|
| Variables | Sensitivity | Specificity | PPV | NPV | Accuracy |
| **Gender** | | | | | |
| Male | 71.43% | 89.19% | 71.43% | 89.19% | 84.31% |
| Female | 66.67% | 100.0% | 100.0% | 91.67% | 92.86% |
| **Age Group** | | | | | |
| 20 – 30 Years | 50.00% | 87.50% | 66.67% | 77.78% | 75.00% |
| 31 – 40 Years | 100.0% | 80.00% | 71.43% | 100.0% | 86.67% |
| 41 – 50 Years | 50.0% | 100.0% | 100.0% | 94.74% | 95.0% |
| > 50 Years | 66.67% | 91.67% | 80.00% | 84.62% | 83.33% |
| **Side of Involvement** | | | | | |
| Right | 70.00% | 85.71% | 70.0% | 85.71% | 80.65% |
| Left | 71.43% | 96.30% | 83.33% | 92.86% | 91.18% |

## DISCUSSION

The diagnostic accuracy of bronchoalveolar lavage (BAL) cytology for identifying lung cancer, with histopathology as the gold standard, is of significant interest in both research and clinical practice. Since its initial use in evaluating chest computed tomography (CT) scans of patients with suspected pulmonary nodules, BAL cytology has proven to be an important diagnostic method that provides pathological material without requiring surgical biopsy [14]. However, patient and procedural factors necessitate high sensitivity and specificity.

The size of nodules plays a critical role in diagnostic accuracy; smaller or deeper lesions may yield fewer representative cells for adequate sampling. In contrast, larger, centrally located nodules tend to shed more cells into the bronchoalveolar space, potentially increasing diagnostic yield [15]. The volume and skill involved in lavage can enhance specimen quality and quantity, with experienced bronchoscopists more likely to obtain conclusive results.

Despite being the gold standard for diagnosis, histopathology is susceptible to inter-observer variability due to differences in tissue sampling, laboratory techniques, and pathologist interpretation. This variability can complicate cytology evaluations, particularly for low or non-representative biopsies [16-17]. Consequently, while BAL cytology is a useful minimally invasive modality for lung cancer detection and diagnosis, optimizing procedural and specimen criteria can improve reliability and certainty.

Bronchial fluid analysis, despite its challenges, holds significant potential. It allows localized retrieval and enables the assessment of distant lesions non-invasively [18]. Additionally, serial sampling facilitates monitoring changes over time. Advances in immunohistochemical and molecular procedures have enriched histological understanding, revealing detailed portraits of lung cancer-associated aberrant cell types.

Our study of 65 patients revealed the diagnostic utility of BAL cytology for lung cancer, with a sensitivity of 70.59% and specificity over 91%. These metrics reinforce the test's utility as a diagnostic tool, particularly when evaluated through cytological inspection. The positive predictive

value was 75%, the negative predictive value was 89.80%, and the overall diagnostic accuracy was 86.15%, underscoring its importance for clinical decision-making regarding treatment plans.

These findings align with previous studies. Sareen R et al. reported a diagnostic accuracy of 83.67%, with a sensitivity of 72.69%, specificity of 100%, PPV of 100%, and NPV of 76.95%[12]. Yang W et al. demonstrated diagnostic accuracy, sensitivity, and specificity of 92.9%, 95.3%, and 95.7%, respectively [20]. Binesh F reported a diagnostic accuracy of 70.5%, with sensitivity and specificity of 46.9% and 91.6%, respectively (PPV=83.4%; NPV=65.8% [21]. Another study showed sensitivity and specificity of bronchial cytology at 60% and 89%, with a PPV of 90%, NPV of 58.62%, and diagnostic accuracy of 71.42% [22].

The moderate sensitivity of BAL cytology, combined with its high specificity and overall accuracy, highlights its complementary role to histopathology in diagnosing pulmonary nodules. Continuous refinements in cytological techniques are likely to enhance its diagnostic power further. The use of BAL cytology in evaluating severe pleural effusions and suspected lesions on CT scans, indicative of primary lung cancer, can aid early and accurate diagnosis, facilitating appropriate management plans and improving patient outcomes.

Limitations of this study include the relatively small sample size and the single-center design, which may limit the generalizability of the findings. Future research should focus on larger, multi-center studies to validate these results and explore the integration of advanced molecular techniques with BAL cytology.

## CONCLUSION

Bronchoalveolar lavage (BAL) was found to be a highly specific and overall accurate diagnostic tool for assessing lung carcinoma. BAL cytology significantly enhances precise diagnosis, demonstrating acceptable sensitivity and predictive values among patients. These findings underscore its efficacy as a valuable diagnostic tool in clinical settings.

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