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A STUDY ON SPUTUM CYTOLOGY FOR THE DIAGNOSIS OF LUNG CANCER IN SKIMS MEDICAL COLLEGE AND HOSPITAL SRINAGAR, JAMMU AND KASHMIR

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ABSTRACT

The case of lung cancer has been found to be among the major causes of cancer-related morbidity and mortality globally mainly because it is usually diagnosed at its advanced stages and early diagnosis is likely to enhance the survival rate. Cytology of sputum is an easy, non-invasive, and inexpensive method of diagnosis, which is particularly useful in the framework of resource limitations, but the diagnostic properties of cytology should be compared with the performance of histopathology as a gold standard. This is a cross-sectional study that was undertaken in the Department of Pathology, SKIMS Medical College and Hospital, Srinagar, and was performed over a six-month duration (1 February 2025 to 31 July 2025) and involved 51 clinically and radiologically suspected lung malignancy cases. Three sequential sputum samples (collected early in the morning) were taken out of each participant and tested cytologically, the results were in negative/suspicious/positive and the results were compared with histopathological biopsy. Histopathology proved the presence of lung cancer in 4 out of 49 cases (7.8%), and sputum cytology proved all 4 malignant cases and all 47 non-malignant cases as negative reporting 0-100% concordance with histopathology with no false-positive or false-negative cases. The cytology positivity occurred more frequently in males, smokers, and patients older than 40 years old, and all the cytology-positive patients reported with the presence of hemoptysis and/or unaccounted weight loss. The study concludes that sputum cytology has great diagnostic accuracy and specificity and can be used as dependable adjunct tool in the diagnosis of lung cancer in a suspected population, especially the high-risk population in a healthcare institution that has limited resources.

Keywords: *Lung cancer; sputum cytology; histopathology; diagnostic accuracy; hemoptysis; SKIMS Srinagar.*

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1. INTRODUCTION

Lung cancer poses a significant health issue to the people worldwide and it has consistently been one of the biggest cause of cancer-related morbidity and mortality in both men and women. The general prognosis of lung cancer is low regardless of the current advancements in the diagnostic procedures, therapeutic treatment modalities, and cancer education programs. One of the factors which contributed to such a poor prognosis is the fact that a high percentage of cases of lung cancer are detected at an advanced stage when the disease has already developed further and the chances of providing a curative treatment are left very poor. During the initial phases, lung cancer has a tendency of being clinically silent and where symptoms are manifested, they are normally not specific and they resemble common respiratory ailments. Consequently, patients can present initially with complaints of persistent cough, breathlessness, and chest pains, recurrent infections of the respiratory system, or even constitutional symptoms, e.g., unexplainable weight loss and fatigue. Such manifestations may not necessarily make one suspect malignancy and thus delays in diagnosis will occur causing high mortality. Therefore, early diagnosis and early confirmation of lung cancer are important in enhancing patient survival, minimizing complication occurrence of the disease, and overall healthcare burden.

Histopathological study of tissue collected by means of biopsy procedures has long been considered the gold standard of definitive diagnosis of lung cancer. Histopathology helps to precisely confirm the presence of malignancy and give the necessary information about the type of tumour, grade, and level of differentiation, which is extremely important when it comes to the prognosis and choice of the treatment methods. But the collection of tissue biopsy normally involves invasive methods, including bronchoscopy-guided biopsy, trans-thoracic needle aspiration/ biopsy, or surgery. These procedures have proven to be effective, but they may not necessarily work with every patient. Most of the suspected lung cancer patients are elderly with poor pulmonary reserves and high-stage disease or severe comorbidities like cardiovascular disorders, chronic obstructive pulmonary disease (COPD), bleeding predisposition, or general weakness which predispose patients to invasive procedures. Also, biopsy method can result in pneumothorax, bleeding, infection, respiratory distress and post-procedural morbidity. Besides that, in resource-limited contexts, the absence of dedicated diagnostic facilities, low access to bronchoscopic services, and delayed access to invasive

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procedures can also impact the timely diagnosis. Hence, there is the necessity of less invasive and easier procedures of diagnostic assessment that could be used as auxiliary tools with a view to the early detection of malignancy.

Against this background, cytology-based diagnostic methods have found their way as useful options or supplementary methods used to analyze the suspected cases of lung cancer. The benefits of cytological techniques like sputum cytology, bronchoalveolar lavage (BAL), bronchial washings, and bronchial brushings include having less invasiveness than tissue biopsy and can be conducted with minimum of risks and discomfort to the patient. Sputum cytology is one of these diagnostic techniques, which is of particular clinical significance because it is simple, cost-effective, non-invasive, and has a simple sample. It is important especially when the patients are aged, debilitated or medically inable to participate in invasive procedures. Sputum cytology works on the principle that malignant tumours of the bronchopulmonary system particularly centrally located bronchogenic carcinomas are also likely to secrete tumour cells into bronchial secretions. Expatriated cells of malignancies are shed into the sputum and can be observed under the microscope after adequate preparation of smear and staining. Thus, sputum cytology has always been regarded as a valuable screening procedure, as well as a support diagnostic instrument, particularly in high-risk patients, including chronic smokers or those with suspicious respiratory symptoms.

Nevertheless, diagnosis and accuracy of sputum cytology is dependent on various factors. Major determinants of the rate of detection are the adequacy and quality of the sputum sample. Early morning sampling is also a proper sample collection technique which raises the chances of detection of malignant cells when sputum samples are obtained on consecutive days. Furthermore, prompt fixation, the correct staining method, and correct interpretation of results by qualified cytopathologists are essential to proper reporting. The technique of repeated sampling enhances sensitivity because shedding of tumour cells can be intermittent in nature. Under such circumstances where these methodological factors are standardized, sputum cytology can prove to be very specific and very helpful in making a diagnosis concerning lung malignancies especially in cases where an invasive diagnostic test cannot be conducted or in cases where an initial test fails to furnish a conclusive diagnosis.

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Based on the considerations above, the current research was done to determine the underlying effectiveness of sputum cytology in assessing the diagnosis of patients clinically and radiologically suspected of having lung cancer. The objective of the study was to compare the sputum cytology results with the histopathological diagnosis to determine the degree to which it is diagnostic and its effectiveness as an adjunct measure in the early diagnosis and treatment of lung cancer especially in the high-risk groups and in the under-resource medical facilities.

1.1.Objectives of the study

- To evaluate the sensitivity and specificity of sputum cytology for malignant cellular changes associated with lung cancer.
- To investigate diagnostic accuracy of sputum cytology among patient groups based on age, gender, smoking history, and clinical parameters.

2. REVIEW OF LITERATURE

Travis et al. (2015) published the fourth edition of the WHO Classification of Tumours of the Lung, Pleura, Thymus and Heart as an authoritative international reference in the histopathological diagnosis and classification of malignancies of the lungs. The standardisation of their work was in terms of the definition of tumours and histological criteria; this allowed standard reporting and better consistency in diagnosis between institutions. The taxonomy further enhanced the knowledge of tumour morphology and variants, which helped in proper subtyping, estimation of prognosis, and treatment. The introduction of new pathologic knowledge made the WHO classification play a crucial role in evidence-based diagnosis of lung cancer and strengthened histopathology as the basis of establishing a definitive diagnosis of tumours.

Beasley, Brambilla, and Travis (2005) considered the 2004 WHO lung tumour classification, and stated that the new system provided a better method of classifying lung tumours by minimising diagnostic uncertainty and the underlying histological heterogeneity. According to them, precise classification of tumours was necessary since the various subtypes of carcinoma varied in their biological behaviour, prognosis and response to therapy. In their review, the authors have highlighted that the revised WHO guidelines enhanced the prognosis of diagnostic

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reproducibility, as the major types of lung carcinoma including squamous cell carcinoma, adenocarcinoma, and small cell carcinoma are distinctly differentiated. They also emphasized the clinical significance of standard pathological terminology in the comparisons of epidemiological patterns, research results and treatment outcomes among various populations.

Rosai (2011) wrote a detailed description of the overall principles of tumour pathology and offered specific microscopic diagnostic criteria of pulmonary neoplasma. It also discussed morphological pattern of lung cancers and detailed the characteristics like cellular atypia, tumour architecture, mitosis, necrosis and stromal invasion which were useful in establishing malignancy, as well as distinguishing between tumour subtypes. Systematic histopathological examination was also highlighted in the work as the gold standard method of diagnosis especially in differentiating benign lesions and malignant tumours and as a method of establishing definitive diagnosis. The works of Rosai contributed to the key role of tissue biopsy and histological assessment in the clinical diagnostics pathology and oncology decision-making.

Schreiber and McCrory (2003) systematic reviews on the published data on the diagnostic efficacy of the various modalities in suspected cases of lung cancer and evaluated their relative specificity and sensitivity. They conducted comparisons on these techniques, sputum cytology, bronchoscopy, needle biopsy, and imaging techniques, and reported that the diagnostic yield was dependent on the location of tumours, adequacy of samples, and procedural factors. They found that in their evidence-based review sputum cytology was useful as a non-invasive diagnostic method especially in centrally located bronchogenic carcinoma whereby the tumour cells find it easy to secrete into sputum. They further observed that the sputum cytology was still useful in the patients who could not undergo invasive practices but it had to be effective with the proper collection of the specimens and cytology interpretation.

Cibas and Ducatman (2020) provided a detailed description of diagnostic cytology and focused specifically on the correlation between the cytological results and the clinical outcomes. The authors explained the principles of cytological analysis, such as the collection of the specimen, methods of its preparations, staining, and microscopic analysis of the cell morphology. Their work brought out the importance of detecting malignant cellular changes that included high nuclear-cytoplasmic ratio, nuclear pleomorphism, hyperchromasia, irregular

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nuclear membranes, prominent nucleoli, and abnormal mitosis, which were critical in distinguishing between benign reactive changes with malignant changes. They also highlighted that, cytological diagnosis would require proper sampling, correct preparation of slides and skills of the cytopathologist since poor specimen could result to false-negative interpretation.

3. MATERIALS AND METHODS

The current research was to determine the diagnostic capabilities of sputum cytology in the detection of lung cancer in the clinically and radiologically suspected cases. The cross-sectional descriptive and analytical research was conducted among the Department of Pathology, SKIMS Medical College and Hospital, Bemina, Srinagar, Jammu & Kashmir, in a period of six months, i.e., 1 February 2025 to 31 July 2025. Fifty-one patients referred to the OPD and IPD departments with a suspicion of lung malignancy were recruited according to preset inclusion and exclusion criteria. The participants who were eligible were adults of 18 years old and above with the clinical symptoms indicative of lung cancer including persistent cough, hemoptysis, chest pain, dyspnea, and unexplained weight loss with radiological evidence that provokes suspicion of malignancy. The patients who had already been diagnosed or treated with lung cancer, patients who could not give sufficient sputum samples, patients with acute lung infections (without radiological suspicion), and patients who failed to give informed consent were not included in the study.

3.1. Study design and setting

The current study was a cross-sectional and descriptive research study that was structured as a hospital-based study. It took place in Department of Pathology, SKIMS Medical College and Hospital, Bemina, Srinagar, Jammu & Kashmir. The environment was the source of access to patients attending outpatient and inpatient services thus making it possible to include clinically suspicious patients that might have lung malignancy and need diagnostic assessment. This research was done to determine the utility of sputum cytology in diagnosis and correlation of cytological results with histopathological confirmation.

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3.2. Study duration

The research was conducted in six months, 1 February 2025- 31 July 2025. This time gave sufficient time to collect sufficient samples and do cytological examination and histopathological correlations wherever biopsy specimen is present.

3.3. Study population and sample size

The study involved 51 patients. Both the OPD and IPD departments were used to select these patients based on clinical and radiological suspicions of lung malignancy. Every registered patient received the process of sputum cytology examination as the diagnostic work-up. The sample size was the number of suspected cases coming out within the study period and eligibility.

3.4. Inclusion criteria

- Age ≥18 years
- Clinical suspicion: chronic cough, hemoptysis, chest pain, weight loss, dyspnea
- Radiological suspicion of malignancy
- Willing to provide sputum samples

3.5. Exclusion criteria

- Previously diagnosed/treated lung cancer
- Inability to produce adequate sputum sample
- Acute pulmonary infection without radiological suspicion of malignancy
- No informed consent

3.6. Specimen collection and processing

The sputum samples were gathered in standardized settings in order to achieve optimality in the diagnosis. All of the registered patients were advised to give three sequential early morning

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sputum samples since early morning sputum has a better concentration of cells and enhances the detection of malignant cells. The samples were taken to the laboratory immediately and processed within 30 minutes to avoid degeneration of cells.

In preparing the smears, representative samples of sputum (ideally thick and mucoid) were picked, and the smears were prepared on clean slides of glass. The smears were then first fixed as quickly as possible in 95% ethyl alcohol in 1530 minutes in order to maintain cellular morphology. Next, procurement of stains Slides were then stained with standard cytology stains, and examined under microscopes. A trained pathologist conducted microscopic analysis under light microscopy in order to identify any malignant or suspicious cellular change.

3.7. Cytology reporting

- Microscopic examination Sputum cytology smears were divided into three diagnostic groups after microscopic examination:
- **Negative for malignancy:** smears with benign respiratory epithelial cells, inflammatory cells, macrophages and no malignancy.
- **Suspicious for malignancy:** smears with anomalous cells with some malignant aspects but not enough to warrant definitive malignancy.
- **Positive for malignancy:** smears of undoubted malignant cells with typical cytological appearance, including pleomorphism, hyperchromasia, abnormal nuclear contours, elevated nuclear-cytoplasmic ratio.
- These categories have been correlated with the histopathological findings.

3.8. Histopathology correlation (Gold standard)

The gold standard of confirmation of lung cancer was deemed to be histopathological diagnosis. In the case of the patients who were subjected to the diagnostic biopsy, the tissues samples were collected with the help of:

- **Bronchoscopic biopsy**, especially in centrally located lesions,

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- **Transthoracic needle biopsy**, commonly for peripheral lesions, or
- **Surgical specimens**, when operative procedures were performed.

There was a normal processing of biopsy specimens in the pathology lab. The tissue was fixed and embedded in paraffin blocks and cut into thin sections and stained with Hematoxylin and Eosin (H&E) stain. The pathologists completed the histopathological reports, and the results were compared with the results of the sputum cytology to determine the diagnostic performance measures, including sensitivity, specificity, and accuracy.

4. RESULTS AND DISCUSSION

The findings of the current research were derived to reveal the diagnostic effectiveness of sputum cytology in detecting lung cancer among clinically and radiologically suspected patients, and the histopathological analysis was taken to be the gold standard. The study involved a total of 51 cases, and the results were assessed systematically using major analytical elements which are histopathological confirmation of malignancy, sputum cytology correlation with histopathological outcome as well as calculation of diagnostic validity parameters including sensitivity, specificity, predictive values and the overall accuracy. Besides, the correlation of the positivity of sputum cytology with key demographic and risk factors (gender and smoking status) was evaluated to determine the distribution of malignancy across high-risk populations. The findings are summarized, and they are presented in the following tables to have an easy interpretation and comparison.

Table 1. Histopathological diagnosis of cases (n = 51)

Histopathological Diagnosis	**Frequency (n)**	**Percentage (%)**
Lung cancer confirmed	4	7.8
No lung cancer	47	92.2
Total	**51**	**100**

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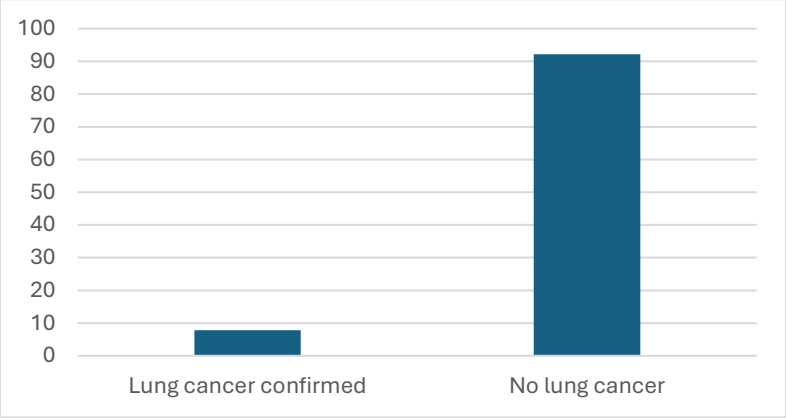

Figure 1: Gold standard diagnosis was established based on histopathological examination of tissue samples.

Table 1 shows the histopathological (gold standard) diagnosis of the 51 clinically and radiologically suspected cases that were used in the study. Lung cancer was confirmed by histopathology in 4 cases (7.8%), whereas the rest of 47 cases (92.2%) had no traces of malignancy. This shows that a low percentage of suspected cases were found to be malignant on a definite tissue determination, therefore the necessity of confirmatory diagnostic means of determining true lung cancer among the other non-malignant respiratory illness with similar clinical and radiographical appearances.

Table 2. Correlation of sputum cytology with histopathology (n = 51)

Sputum Cytology Result	**Lung Cancer Present**	**Lung Cancer Absent**	**Total**
Positive	4	0	4
Negative	0	47	47
Total	**4**	**47**	**51**

Table 2 indicates the correlation of findings of sputum cytology against histopathological diagnosis (gold standard) in 51 suspected cases. The cytology on sputum showed 4 positive results and all these were reported as the presence of lung cancer on histopathology (true

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positives = 4). On the same note, 47 cases were reported as cytology negative with all of them being identified to be non-malignant on histopathology (true negatives = 47). Notably, the study did not have any false-positive and false-negative results. This means that sputum cytology had full concordance with histopathology which is the test of high diagnostic reliability and a high degree of agreement with the gold standard in the diagnosis of both malignant and non-malignant cases.

Table 3. Diagnostic validity of sputum cytology (n = 51)

Parameter	**Value**
Sensitivity	100%
Specificity	100%
Positive Predictive Value (PPV)	100%
Negative Predictive Value (NPV)	100%
Diagnostic Accuracy	100%

Table 3 sums up the diagnostic validity of sputum cytology against histopathology (gold standard) in cases of 51 suspected cases. The sensitivity of the test was found to be 100 that is, it was able to detect all the histopathologically verified cases of lung cancer and did not miss any malignant case (no false negatives). The specificity of 100% proved that the total number of non-malignant cases was correctly reported as negative (no false positives). Also, the positive predictive value (PPV) of 100% demonstrated that all cytology-positive reports were actually lung cancer and the negative predictive value (NPV) of 100% was that all cytology-negative results were non-malignant. In general, the diagnostic accuracy of sputum cytology was 100% which shows that the sputum cytology showed good results as a diagnostic device within the study group.

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Table 4. Risk factors (Gender & Smoking) with cytology positivity (n = 51)

Variable	Category	Total (n)	Cytology Positive (n)	Cytology Negative (n)
Gender	Male	32	3	29
	Female	19	1	18
Smoking	Smokers	30	3	27
	Non-smokers	21	1	20

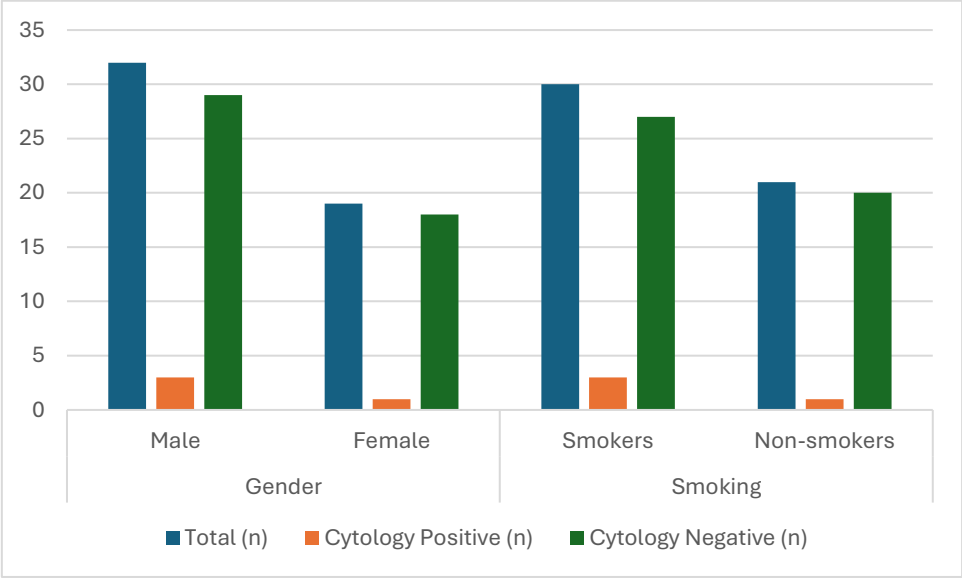

Figure 2: Risk factors (Gender & Smoking) with cytology positivity

Table 4 represents the spread of sputum cytology results according to the main risk factors, i.e. gender and smoking status, among the participants of the research (n=51). Males overtook the cases (32/51) and presented more cases with cytology positive results (3 cases) in comparison to the females (1 positive case out of 19), which showed that cytological evidence of malignancy was more common in males than in females. In regards to smoking status, the cytology positivity was more common among smokers with 3 of 30 smokers being cytology positive and only 1 out of 21 non-smokers having cytology positive. These results indicate that

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the male gender and the history of smoking were related to the increased cytology positivity, which evidences the significance of smoking as a key predisposing risk factor of lung cancer and the necessity of simulation screening and early diagnostic assessment in the high-risk population.

5. CONCLUSION

This paper evaluated diagnostic value of sputum cytology in clinically and radiologically suspected lung cancer patients by comparing cytological results with histopathological results. In the study population, Sputum cytology had absolute congruence with histopathology, it identified all the cases of histopathologically confirmed lung cancer cases and had no instances of false-positive, which confirmed the study as having excellent diagnostic reliability. A positive cytology test was found in males, smokers, and patients who are older than 40 years mostly, and is highly correlated with such alarming clinical findings as hemoptysis, unexplainable weight loss. Due to simplicity, non-invasiveness, low cost, and high specificity, sputum cytology may be a useful complement to clinical and radiological examination to early detect lung malignancy especially in high-risk populations as well as in health care facilities where access to invasive diagnostic tests may be restricted.

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