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ORIGINAL RESEARCH

Comparison of diagnostic accuracy of cytological sampling technique in suspected pulmonary lesions

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ABSTRACT

Aim: This study aimed to compare the diagnostic accuracy of different cytological sampling techniques, including bronchial brushing, bronchoalveolar lavage (BAL), and transthoracic fine-needle aspiration (TTFNA), in diagnosing suspected pulmonary lesions, with histopathology as the gold standard.**Materials and Methods:**This prospective study was conducted in the Department of Pathology at Subharti Medical College, Meerut, from September 2011 to July 2013. Cytological samples were obtained from 178 patients via BAL, bronchial brushings, and TTFNA. Histopathological correlation was available for 47 cases. The adequacy of samples was determined based on established guidelines. Diagnostic accuracy, sensitivity, specificity, and predictive values were calculated for each technique.**Results:**Of the 178 cases, BAL was performed in 135 (75.84%) patients, brushings in 44 (24.72%), and TTFNA in 57 (32.02%) cases. Maximum malignancies were detected by TTFNA, with a sensitivity and specificity of 100%. For BAL, diagnostic accuracy was 71.4%, and for brushings, it was 87.5%. Histopathological confirmation was available in 47 cases, with squamous cell carcinoma being the most commonly diagnosed malignancy.**Conclusion:**TTFNA demonstrated the highest diagnostic accuracy, followed by bronchial brushings and BAL. Each method's effectiveness varies depending on the lesion type and location, emphasizing the importance of using multiple diagnostic modalities for pulmonary lesions.

Keywords: Pulmonary lesions, cytology, bronchoalveolar lavage, fine needle aspiration, diagnostic accuracy.

INTRODUCTION

The major focus of respiratory cytology is on the diagnosis of lung cancer as it is now reported to be the most commonly diagnosed malignancy in the world among males. The incidence of lung cancer is also increasing in females. Other than lung cancer, pulmonary cytology also helps in establishing diagnosis in various non-malignant cases.[1] Lung lesion may present as nodule or a mass. SPN is defined as an X-ray density completely surrounded by normal aerated lung, with circumscribed margin of any shape, less than or equal to 3 cm. in greatest diameter.[2] Lung lesions >3cm in size are defined as lung masses. Approximately 35% of all such lesions in adults are malignant, mostly being primary lung cancer.[3]Tobacco use is the single most important risk factor for cancer.[4]

For the diagnosis of suspected lung lesions, there is a range of procedures to choose from but main goals in selecting a specific diagnostic modality are as follows:

1. to maximize the yield of the selected procedure for diagnosis of the lesions,
2. staging of neoplastic process if diagnosed,
3. to avoid unnecessary invasive tests for the patients, with special attention to the projected treatment plan.[5]

So, the aim of this study is to find out the diagnostic accuracy of different cytological modalities in diagnosing a pulmonary lesion.

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AIMS AND OBJECTIVES

1. To evaluate the role of bronchial lavage/washing, bronchial brushing, and fine needle aspiration in the diagnosis of pulmonary lesions.
2. To compare the relative diagnostic accuracies of various cytological tools in the diagnosis of pulmonary lesions.

MATERIAL AND METHODS

Present study was conducted in the Department of Pathology atSubharti Medical College, Meerutand associated Hospital, on cytological materials (bronchial brushing, bronchoalveolar lavage/wash, and Fine needle aspirates) of the pulmonary lesions, collected and sent to the department of pathology by the clinical department.

DESIGN - Diagnostic test evaluation.

TYPE OF STUDY - Prospective study.

CASES: Study included all the cases diagnosed with pulmonary lesions during a period of two years i.e., from Sept. 2011 to July 2013.

EXCLUSION CRITERIA

- Non-co-operative patients not ready to give consent.
- Patients with no cough reflex (contraindicated for bronchoscopy).
- Patients with abnormal coagulation profiles.
- Highly vascular lesions which bled spontaneously.
- Inadequate samples.

(Cases which were inadequate in one procedure but positive in any other were included for calculations in analysis).

Pulmonary cytology material was obtained as bronchial lavage, bronchial brushing and fine needle aspiration of the lung lesions in a total of 178 cases. Histopathological correlation was done wherever possible.

Bronchoalveolar lavage (BAL) was taken by the pulmonologist during bronchoscopy by flexible fiberoptic bronchoscope. BAL fluid was centrifuged for 5 min. at 1500 rev. per minute and smears (3 dry, 2 wet) were prepared. The bronchial brushings specimens were taken with a brush during bronchoscopy and material were smeared onto the glass slides and fixed immediately by immersing in methanol.

FNA were done under the guidance of ultrasonography or computed tomography with the help of a 22–24-gauge needle and a 20 ml syringe inserted percutaneously into the lung mass.

From these samples, dry and wet smears were made. The methanol fixed smears were stained by Papanicolaou stain and Hematoxylin& Eosin stain. Dry smears were stained by Leishman's stain and ZN stain accordingly.

A bronchoscopic tissue biopsy was taken, wherever possible, if a tumor or any other suspicious lesion was seen during bronchoscopy. The tissue was processed for paraffin block preparation. Thin sections were made by using rotator microtome. All the slides were stained with routine H & E staining method.

The smears were screened for different cells including malignant cells and a cytological diagnosis was made. The diagnosis was correlated with the histopathological diagnosis wherever available.

ADEQUACY

In the present study adequacy was decided according to the criterion given in PAP/NGC Program Review - Defining adequacy in nongynecological cytology, College of American Pathologists, August 2003.[6]

BAL

Smears should demonstrate a specific pathologic process or it should have numerous alveolar macrophages (93% ± 5%) and few lymphocytes, occasional neutrophils and rare ciliated / squamous cells.

BRUSH

Cells or agents diagnostic of a pathologic process should be present in the smears. If the diagnostic cells are absent, many well preserved, optimally stained, ciliated bronchial epithelial cells and few macrophages should be present.

FNA

Cells that explain the radiographic and clinical presentations.

Alveolar macrophages, mesothelial cells and respiratory epithelial cells should be present.

RESULTS

The present study included the cytological materials obtained from a total of 178 patients during the study period, which included BAL from 135 (75.84%) patients, brush from 44 (24.72%) patients and TTFNA from 57 (32.02%) patients.

Table 1: Nature of cytological specimens

Nature	No. of cases	Percentage
BAL	135	75.84
Brush	44	24.72
TTFNA	57	32.02

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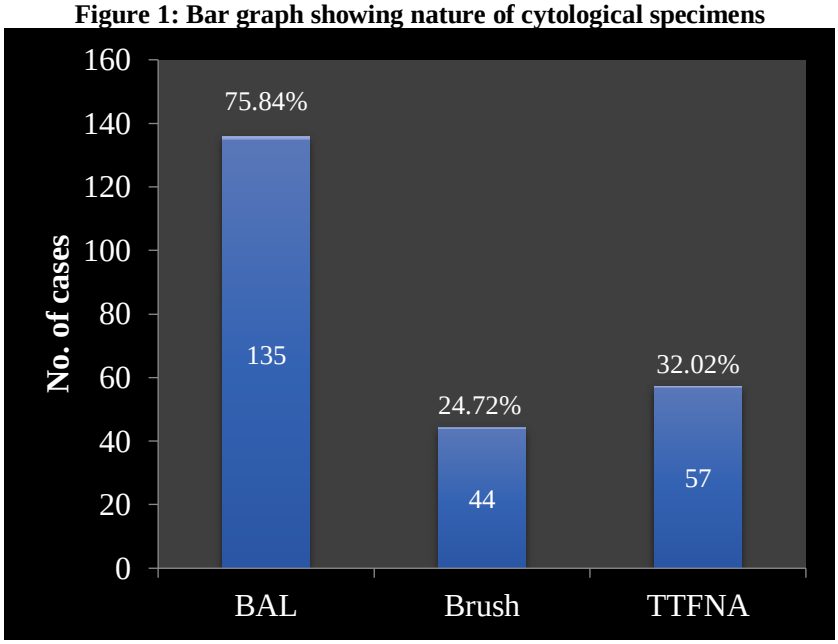
Figure 1: Bar graph showing nature of cytological specimens



Of the total **178** cases, **BAL** with brush was done in **41** cases, **BAL** with **TTFNA** was done in **19** cases, and **Brush** with **TTFNA** was done in only 5 cases.

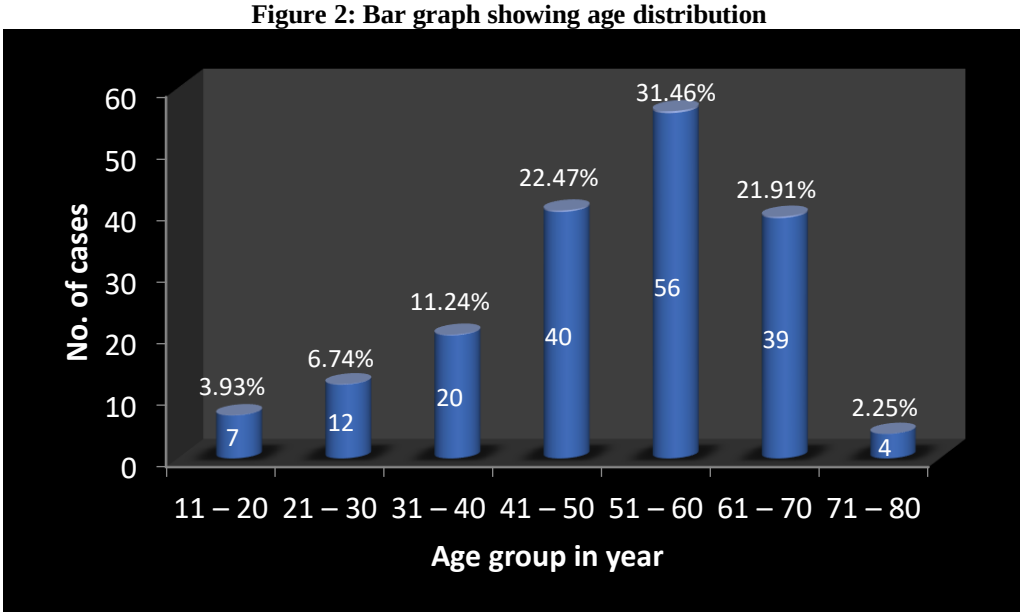
AGE DISTRIBUTION

Of the total 178 cases studied, the youngest patient was 15 years old and the oldest patient was 80 years old, with a median of 55 years and a mean of 57.8 years. Maximum number of cases was in the age group of 4th to 7th decades 135 (75.84%).

Table 2: Age distribution of patients

Age group (in years)	No. of patients	Percentage
11 – 20	7	3.93
21 – 30	12	6.74
31 – 40	20	11.24
41 – 50	40	22.47
51 – 60	56	31.46
61 – 70	39	21.91
71 – 80	4	2.25
Total	**178**	**100.0**

Figure 2: Bar graph showing age distribution



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SEX RATIO

Among the 178 patients of various age groups**,** 144 (80.34%)were males and 34 (19.66%) were females giving a sex ratio of 4:1.

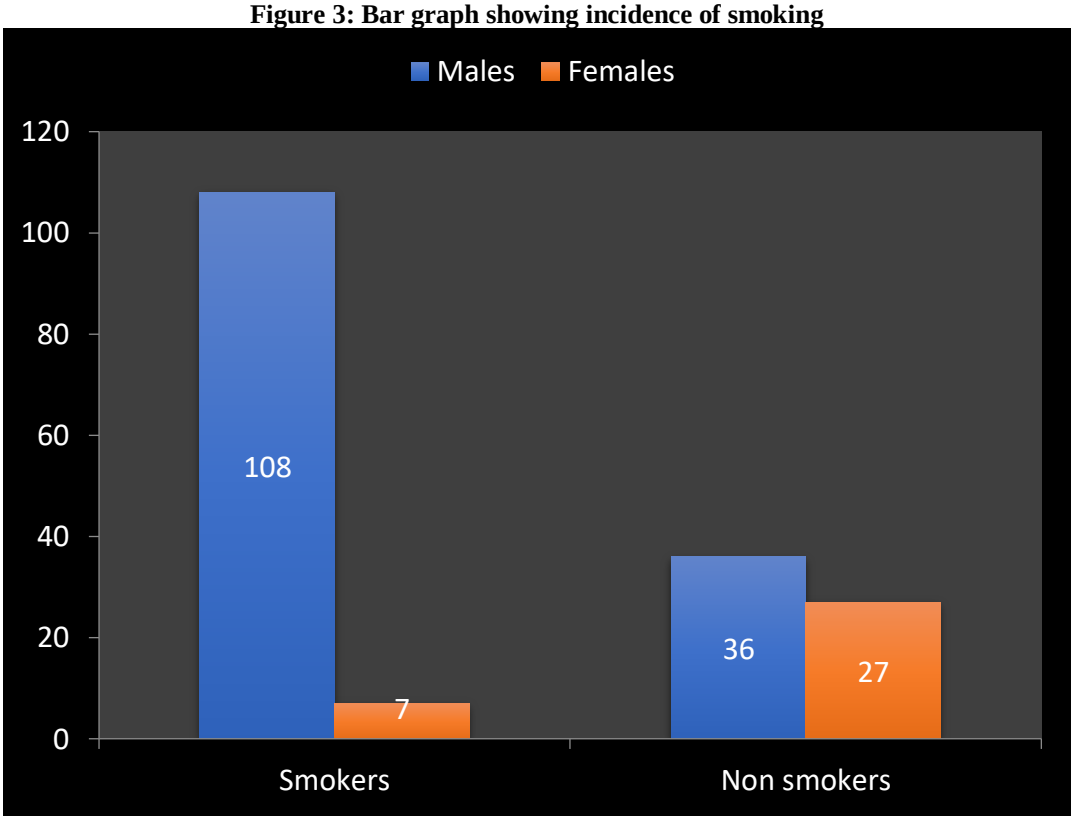
115 patients (108 males and 7 females) were current smokers or had a past history of smoking. 63 patients (36 males and 27 females) were non-smokers.

59 (51.3%) out of 115 smokers were diagnosed with carcinoma lung of different types.

Table 3: Incidence of smoking

Sex	Smokers	Non smokers	Total
Males	108	36	144
Females	7	27	34
Total	**115**	**63**	**178**

Figure 3: Bar graph showing incidence of smoking



The patients presented with various symptoms, most common among which was cough followed by breathlessness, chest pain, haemoptysis, fever and hoarseness of voice. Few cases also presented with other symptoms like weight loss, loss of appetite, difficulty in walking etc.

Table 4: Chief symptoms of the study group

S. No.	Symptoms	Total	Percent
1	Cough	92	51.68
2	Breathlessness	81	45.5
3	Fever	52	29.2
4	Chest pain	48	28.57
5	Haemoptysis	42	23.59
6	Hoarseness of voice	6	3.37

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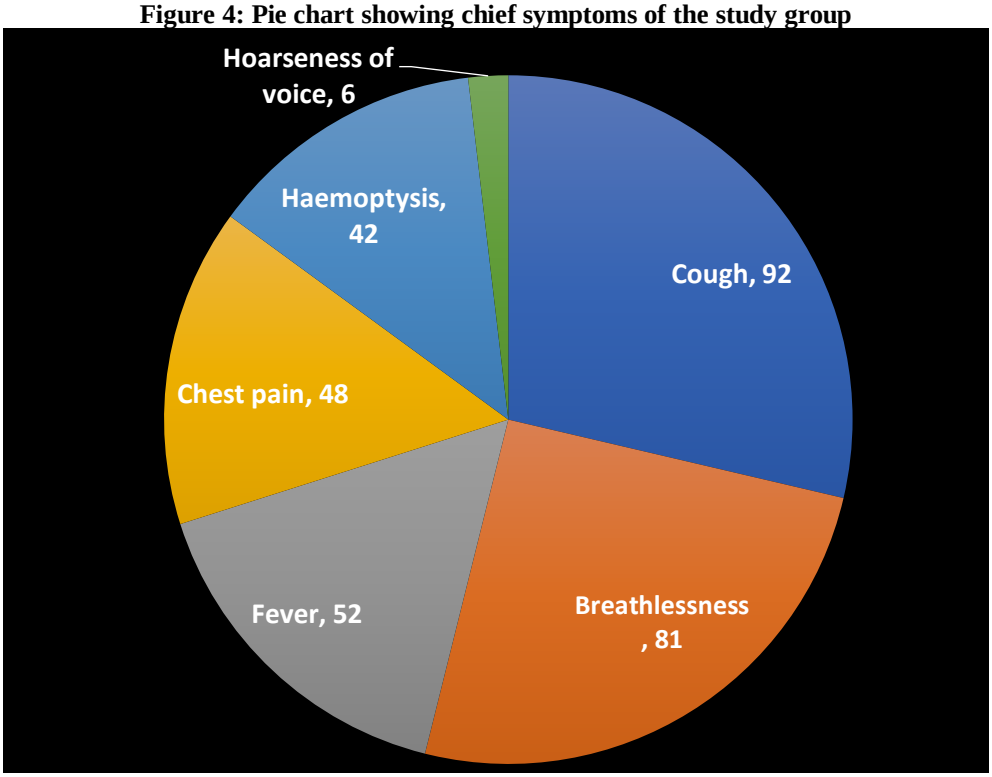
Figure 4: Pie chart showing chief symptoms of the study group



CYTOLOGICAL DIAGNOSIS

The samples received in the laboratory were processed and categorised into four groups based on the cytological features as follows –

Group A- no pathology

Group B- reactive – sub-categorised as B_{1}- metaplastic,

B_{2}- specific (tubercular or fungal)

B3-non- specific inflammation

Group C- suspicious for malignancy

Group D- positive for malignancy

Out of total **135BAL** specimens received, 73 (41.01%) were reactive [34 (19.104%) inflammatory, 31 (17.42%) specific reactive, 8 (4.49%) metaplastic], 10 (5.62%) were suspicious, 9(5.01%) were malignant, 36 (20.22%) showed no pathology and 7 (3.93%) were inadequate. Specific reactive cases included those which came out to be positive for tubercular (29) and fungal infection (2).

Table 5: Cytological diagnosis of BAL specimens

Cytological diagnosis	Number of cases	Percentage
Inadequate	7	3.93
No pathology (A)	36	20.22
Reactive (B) B_1	8	4.49
B_2	31	17.42
B_3	34	19.10
Suspicious (C)	10	5.62
Malignant (D)	9	5.01
Total	**135**	**75.79**

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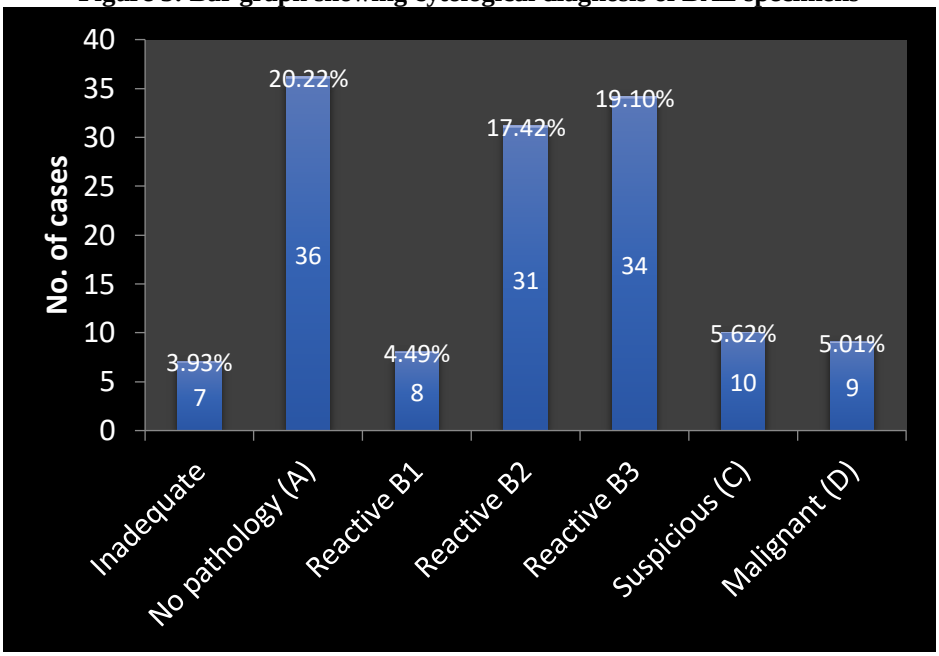
Figure 5: Bar graph showing cytological diagnosis of BAL specimens

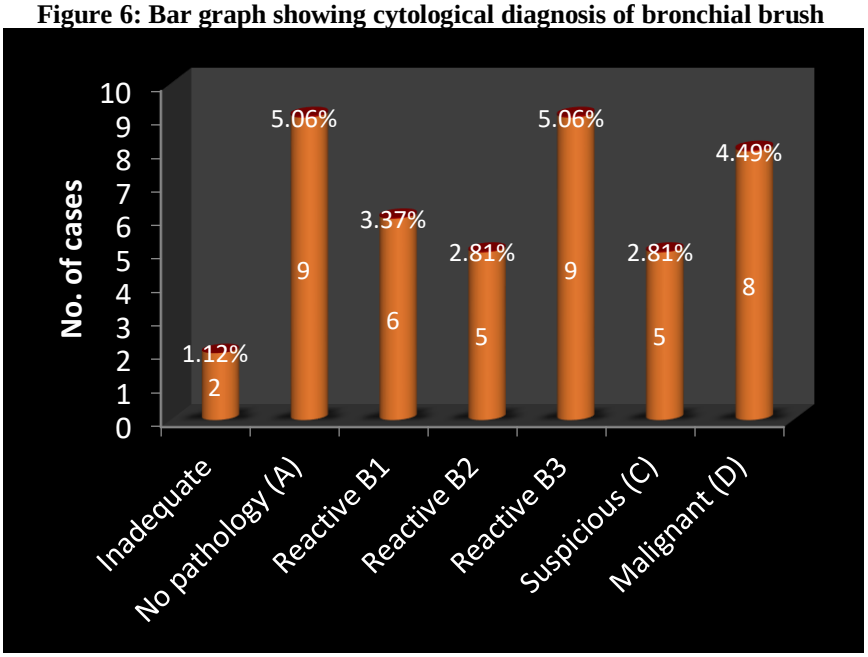


Out of total **44 bronchial brush** samples received, 20 (11.24%) were reactive [9 (5.06%) inflammatory, 5 (2.81%) specific reactive - tubercular, 6 (3.37%) metaplastic], 5 (2.81%) were suspicious, 8 (4.49%) were malignant, 9 (5.06%) showed no pathology and 2 (1.12%) were inadequate.

Table 6: Cytological diagnosis of bronchial brush

Cytological diagnosis	Number of cases	Percentage
Inadequate	2	1.12
No pathology (A)	9	5.06
Reactive (B) B_1	6	3.37
Reactive (B) B_2	5	2.81
Reactive (B) B_3	9	5.06
Suspicious (C)	5	2.81
Malignant (D)	8	4.49
Total	**44**	**24.72**

Figure 6: Bar graph showing cytological diagnosis of bronchial brush



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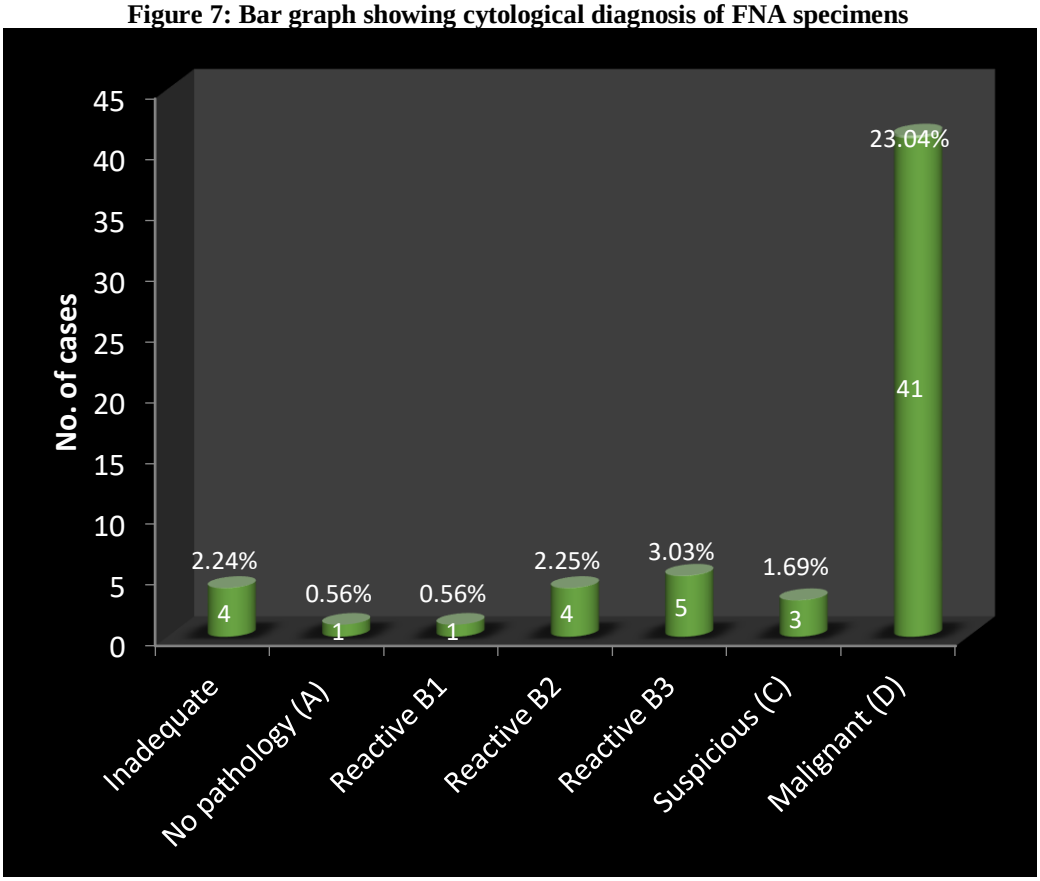
Out of total **57 TTFNA** samples received, 8 (4.49%) were reactive [5 (3.03%) inflammatory, 4 (2.25%) specific reactive (2 tubercular and 2 fungal), 1 (0.56%) metaplastic], 3 (1.69%) were suspicious, 41 (23.04%) were malignant, 1 (0.56%) showed no pathology and 4 (2.24%) were inadequate.

Table 7: Cytological diagnosis of FNA specimens

Cytological diagnosis	Number of cases	Percentage
Inadequate	4	2.24
No pathology (A)	1	0.56
Reactive (B) B_1	1	0.56
B_2	4	2.25
B_3	5	3.03
Suspicious (C)	3	1.69
Malignant (D)	41	23.04
Total	**57**	**32.02**

Figure 7: Bar graph showing cytological diagnosis of FNA specimens



In the present study, cytological samples received were of various types. The diagnostic accuracy for detection of lung lesions in various samples was analyzed.
Of the total **178** cases, **BAL** with **Brush** was done in **41** cases, **BAL** with **TTFNA** was done in **19** cases, and **Brush** with **TTFNA** was done in only **5** cases.

Table 8: Cytological samples received in combination

S. No.	Cytological Sample	Number of cases
1	BAL + Brush	41
2	BAL + TTFNA	19
3	Brush + TTFNA	05

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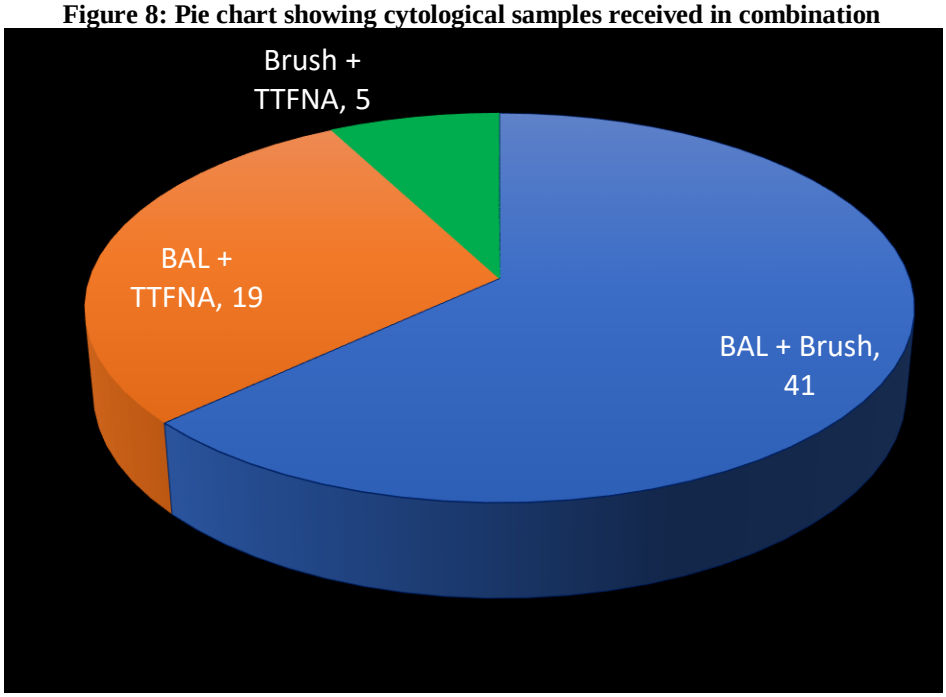
Figure 8: Pie chart showing cytological samples received in combination



RELATIVE DIAGNOSTIC ACCURACY

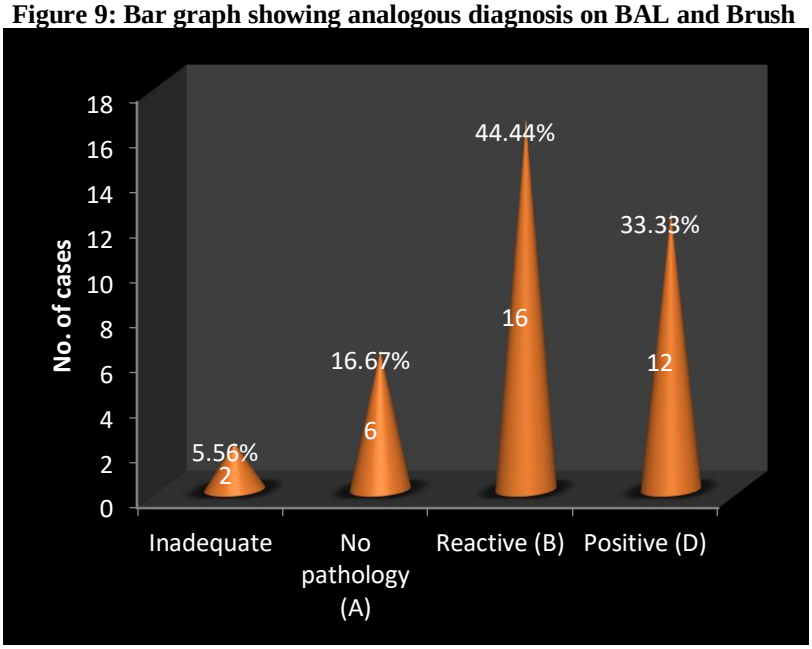
The diagnostic accuracy of detection of lesions in various samples was analyzed. For calculation of diagnostic correlation between different cytologic samples, suspicious category was included in positive for malignancy and inadequate samples were excluded.

Out of **41** cases in which both **BAL** and **Brush** were done simultaneously, 36 cases showed similar diagnosis and 5 cases showed different diagnosis.

Table 9: Analogous diagnosis on BAL and Brush

Cytological diagnosis	BAL + Brush	Percent
Inadequate	2	5.56
No pathology (A)	6	16.67
Reactive (B)	16	44.44
Positive (D)	12	33.33
Total	**36**	**100**

Figure 9: Bar graph showing analogous diagnosis on BAL and Brush



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Five cases had different cytological diagnosis. Two cases were positive on BAL but negative for malignancy on brush, probably because there was no lesion visible on bronchoscopy and hence brush failed to scrape the representative area.

Table10: Different results in BAL and Brush

BAL	Brush	Total number
No pathology (A)	Positive (D)	1
No pathology (A)	Reactive (B_3)	1
Positive (D)	Reactive (B_3)	2
Reactive (B_3)	Positive (D)	1
		5

Out of **19** cases in which both **BAL** and **TTFNA** were done, 8 cases showed analogous diagnosis and 11 cases showed different diagnosis.

Table 11: Analogous diagnosis on BAL and TTFNA

Cytological diagnosis	BAL + TTFNA	Percent
Reactive (B)	4	50
Positive (D)	4	50
Total	**8**	**100**

Eleven cases which had different cytological diagnosis were as follows –

Table 12:Different results in BAL and TTFNA

BAL	TTFNA	Total number
No pathology (A)	Inadequate	2
No pathology (A)	Positive (D)	6
Reactive (B_3)	Positive (D)	2
Reactive (B_2)	Inadequate	1
		11

Brush and **TTFNA** were done only in five cases. 2 cases showed analogous cytological diagnoses which were reactive and positive respectively. Rest of the 3 cases were as follows-

Table 13: Different results on Brush and TTFNA

BRUSH	TTFNA	Total number
Reactive (B_3)	Positive (D)	3

Out of the total 178 cases it was possible to be correlated with the diagnosis made on biopsy in 47 cases. **BAL, Brush** and **Biopsy** were done in **28** cases, **BAL** and **Biopsy** were done in **14** cases and **TTFNA** and **Biopsy** were done only in **5** cases.

Table 14: *Total cyto-histopathological correlated cases*

Techniques	Total number of cases
BAL + Brush + Biopsy	28
BAL + Biopsy	14
FNA + Biopsy	05
Total	47

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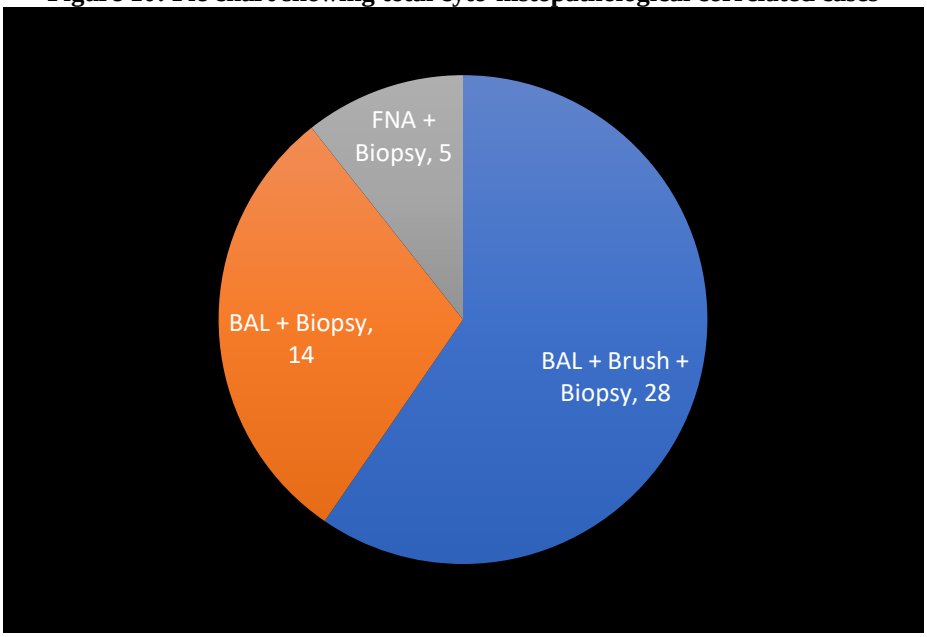
Figure 10: Pie chart showing total cyto-histopathological correlated cases



Of the total **28** cases in which all three techniques were performed, **12** cases showed analogous diagnosis - 6 cases were reactive, 5 were positive for malignancy and 1 showed no pathology respectively on all three.

In rest of the **12** cases, the diagnosis did not supplement each other. **9** of these cases turned out to be malignant on biopsy (including two cases which were inadequate on both BAL and brush), **2** cases showed non-specific inflammation and 1 showed no pathology on biopsy. **4** cases were inadequate on biopsy which was excluded from the study.

Table 15: Different results on BAL, Brush and Biopsy

BAL	Brush	Biopsy	Total No.
No pathology (A)	Reactive (B_3)	Reactive (B_3)	1
Reactive (B_3)	Reactive (B_3)	Positive (D)	3
No pathology (A)	No pathology (A)	Reactive (B_3)	1
Positive (D)	No pathology (A)	Positive (D)	2
Reactive (B_1)	Positive (D)	Positive (D)	1
Reactive (B_1)	No pathology (A)	Positive (D)	1
Reactive (B_3)	Reactive (B_3)	No pathology (A)	1
Inadequate	Inadequate	Malignant (D)	2

Out of the **49** cases where both **BAL** and **Biopsy** were done, analogous diagnoses were made in **28** cases. However, the results of **21** cases did not correspond with each other.

Table 16: Analogous results on BAL and Biopsy

BAL + Biopsy	Total number of cases
No pathology (A)	2
Reactive (B)	14
Positive (D)	12
	28

Table 17: Different results on BAL and Biopsy

BAL	Biopsy	Total number
Inadequate	Positive (D)	4
No pathology (A)	Reactive (D)	3
No pathology (A)	Positive (D)	3
Reactive (B_3)	Inadequate	4
Reactive (B_3)	Positive (D)	7
		21

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Diagnostic accuracy for detection of lesions by BAL in correlation with Biopsy was calculated.
Sensitivity = 70.6%
Specificity = 73.3%
Positive predictive value = 85.7%
Negative predictive value = 52.4%
Diagnostic accuracy = 71.4%
In **31** cases, both **Brush** and **Biopsy** were done which showed similar diagnoses in **17** cases and different results in **14** cases as shown below.

Table 18: Analogous results on Brush and Biopsy

Brush + Biopsy	Total number of cases
Reactive (B)	9
Positive (D)	8
	17

Table 19: Different results on Brush and Biopsy

Brush	Biopsy	Total number
Inadequate	Positive (D)	2
Reactive (B_2)	Inadequate	4
No pathology (A)	Reactive (B_1)	1
Reactive (B_1)	Positive (D)	7
		14

Diagnostic accuracy for detection of lesions by **Brush** in correlation with **Biopsy** was calculated.
Sensitivity = 85.7%
Specificity = 90.1%
Positive predictive value = 94.7%
Negative predictive value = 76.9%
Diagnostic accuracy = 87.5%
Although the total numbers of biopsies done in combination with various other investigations were **55**, only **5** cases had both **TTFNA** and **biopsy** done. Most of the cases for which FNA was done were located in the periphery of the lung and were not visible on bronchoscopy. So, the total number of biopsies for correlation in these cases was low. Out of these five cases four had analogous diagnosis and one case had different diagnosis.
Diagnostic accuracy for detection of lesions by **TTFNA** in correlation with **Biopsy** was calculated.
Sensitivity = 100%
Specificity = 100%
Positive predictive value = 100%
Negative predictive value = 100%
Diagnostic accuracy = 100%
These calculations may not be representative as the sample size was very small for correlation on histopathology.

Table 20: Correlation between cytological and histopathological diagnosis

	Histopathological diagnosis		
Cytological diagnosis	**Malignant**	**Non malignant**	**Total**
Malignant	12	01	13
Non malignant	03	10	13
Total	15	11	26

χ^2= 0.003(significant)

The maximum number of cases were diagnosed as squamous cell carcinoma both on cytology (15) and histopathology (13). 14 cases were diagnosed as poorly differentiated carcinoma, 8 as small cell carcinoma, 7 as adenocarcinoma and 2 as large cell carcinoma on cytology whereas 2 cases were diagnosed as poorly differentiated carcinoma, 6 as small cell carcinoma, 2 as adenocarcinoma and 5 as carcinoma in situ on histopathology respectively.

Table 21: Cancer type on cytology and histopathology

Cancer type	Cytology	Percent	Histopathology	Percent
SCC	15	32.61	13	46.41
SmCC	8	17.40	6	21.43
ADC	7	15.21	2	7.14
PDC	14	30.43	2	7.14
LCC	2	4.34	0	0
CIS	0	0	5	17.86
Total number	**46**	**100**	**28**	**100**

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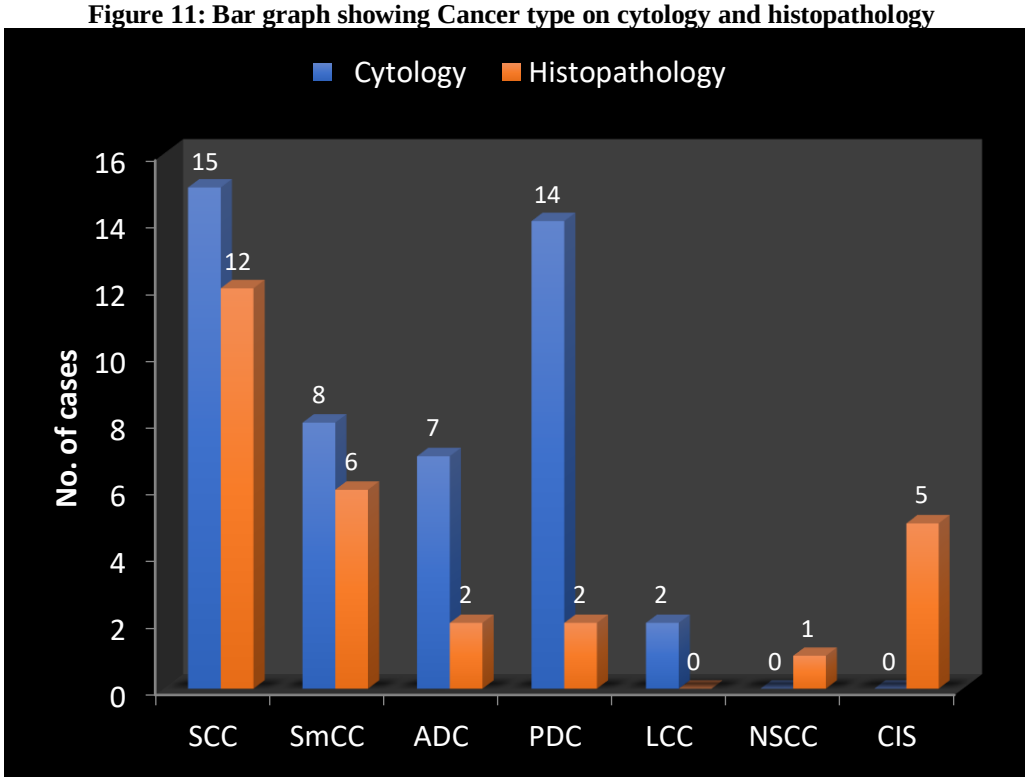
Figure 11: Bar graph showing Cancer type on cytology and histopathology

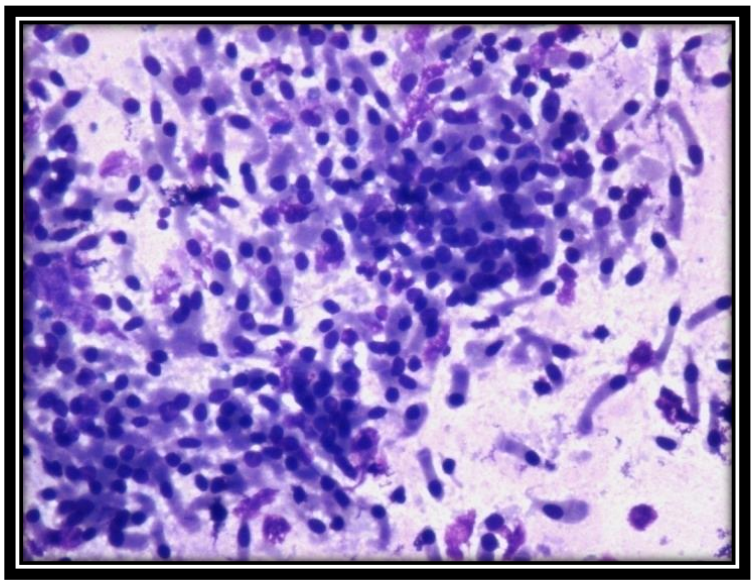


SCC – Squamous cell carcinoma, SmCC – Small cell carcinoma
ADC – Adenocarcinoma, PDC – Poorly differentiated carcinoma
LCC – Large cell carcinoma, CIS – Carcinoma in situ

Table 22 shows overall sensitivity, specificity, positive predictive value and negative predictive value of the various samples received.

Table 22: Overall diagnostic accuracy of BAL, Brush and TTFNA

	BAL	BRUSH	FNA
Sensitivity	70.6 %	85.7 %	100 %
Specificity	73.3 %	90.1 %	100 %
Positive predictive value	85.7 %	94.7 %	100 %
Negative predictive value	52.4 %	76.9 %	100 %
Diagnostic accuracy	71.4%	87.5 %	100 %



Photomicrograph 12: BAL smear showing normal endobronchial cell cluster (Leishman Giemsa x 100)

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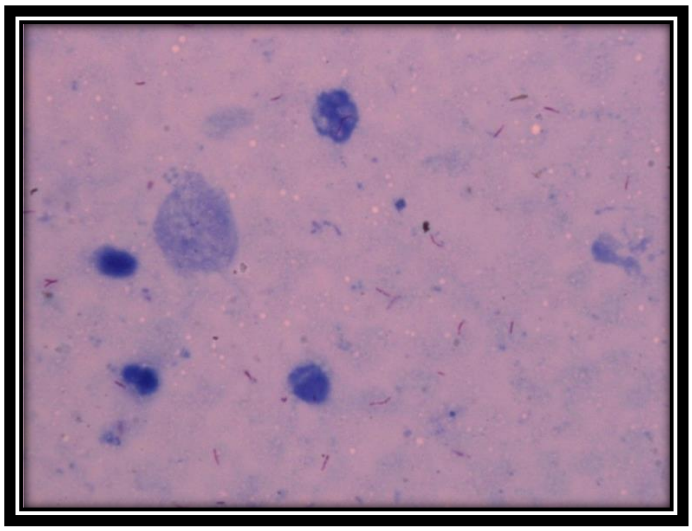
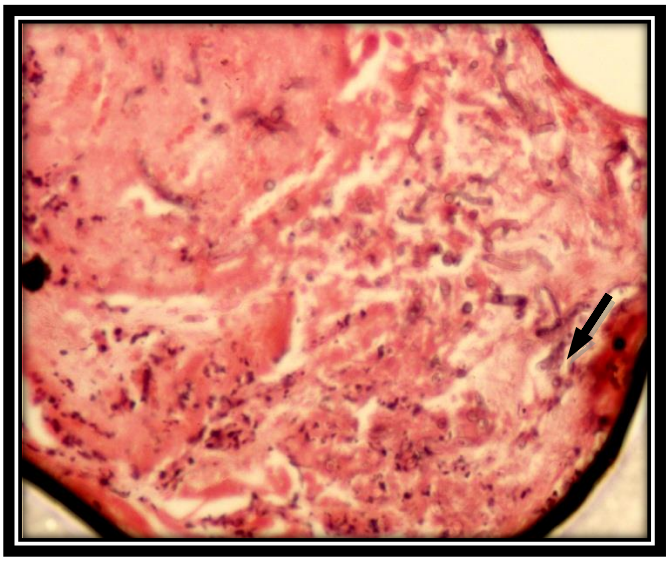
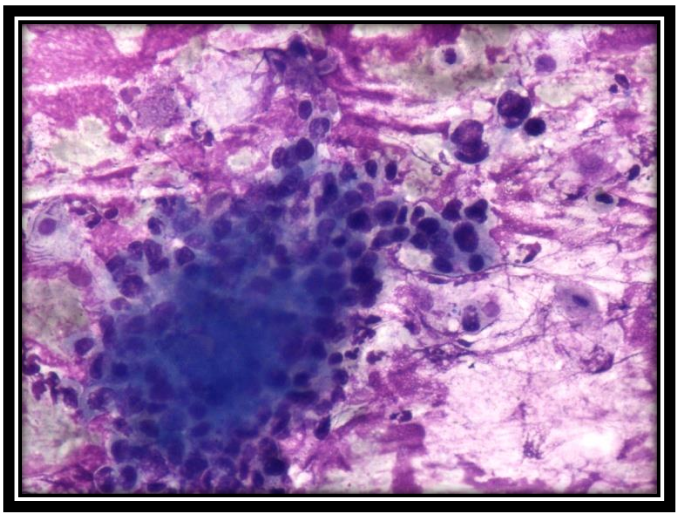


Photomicrograph 13: BAL smear showing AFB on ZN stain (ZN x 1000)



Photomicrograph 14: Endobronchial biopsy showing Fungal hyphae(H&E x 400)



Photomicrograph 15: Brush smear showing Squamous cell carcinoma (Leishman Giemsa x 400)

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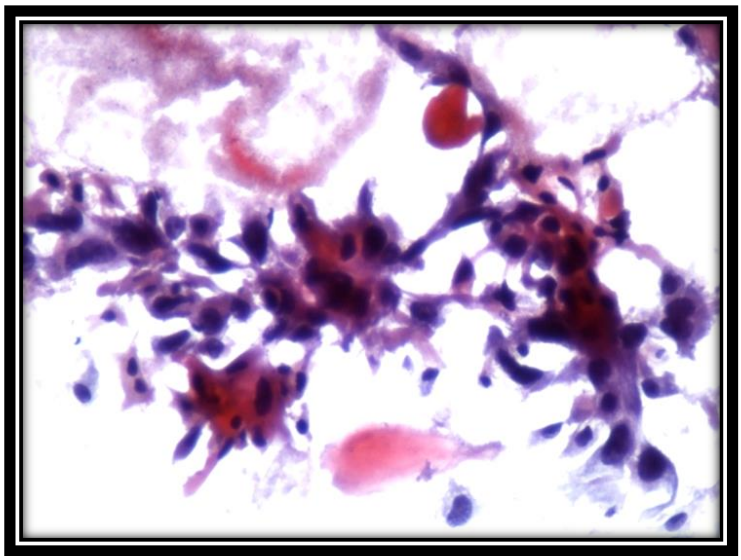
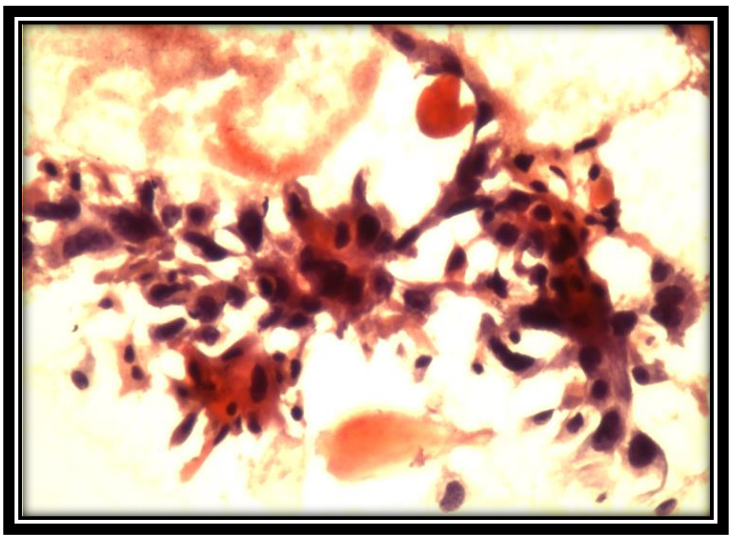
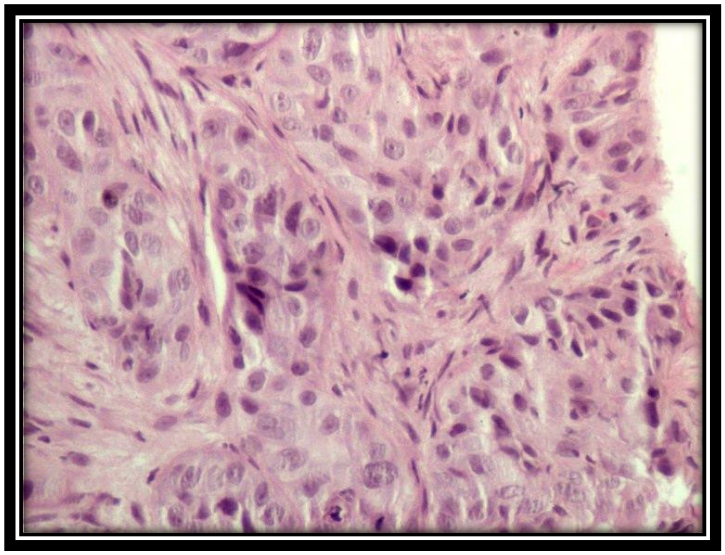


Photomicrograph 16: FNA smearshowing Squamous cell carcinoma(Leishman Giemsa x 400)



Photomicrograph 17: FNA smear showing Squamous cell carcinoma (Pap x 400)



Photomicrograph 18:Bronchoscopic biopsy showing Squamous cell carcinoma of lung (H&E x 400)

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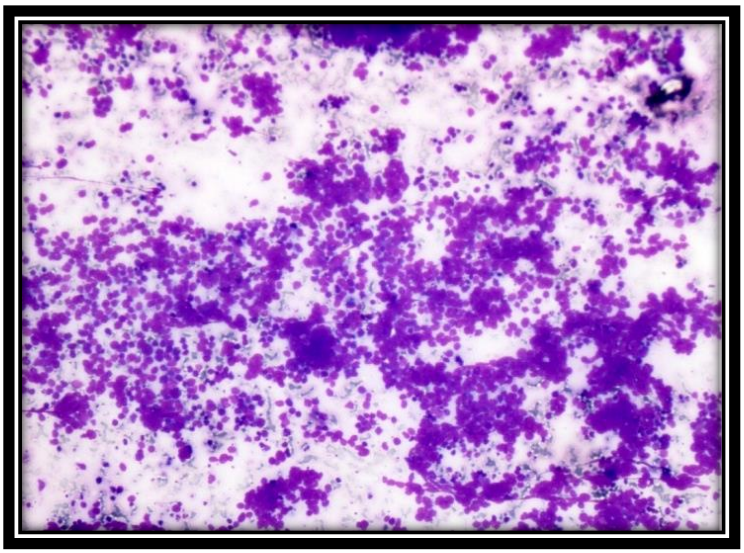
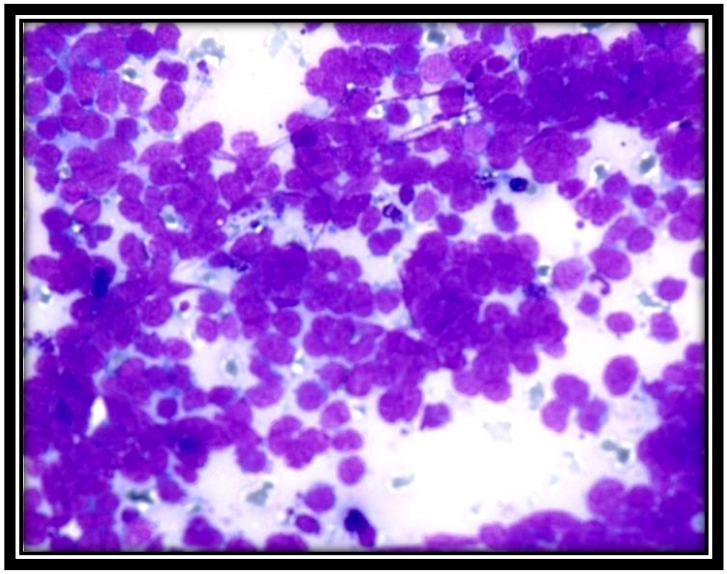
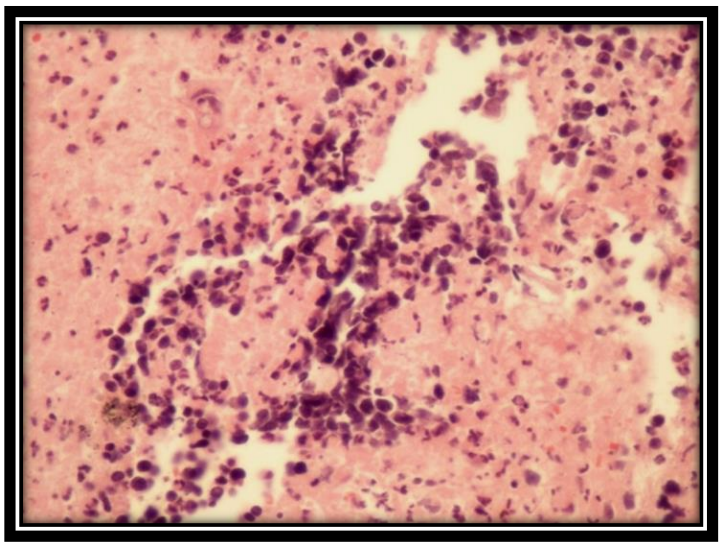


Photomicrograph 19: FNAC showing Small cell carcinoma lung(Leishman Giemsa x 100)



Photomicrograph 20: FNA showing Small cell carcinoma lung - poorly cohesive cells with smudging (Leishman Giemsa x 400)



Photomicrograph 21: Cell block showing Small cell carcinoma exhibiting nuclear molding (H&E x 400)

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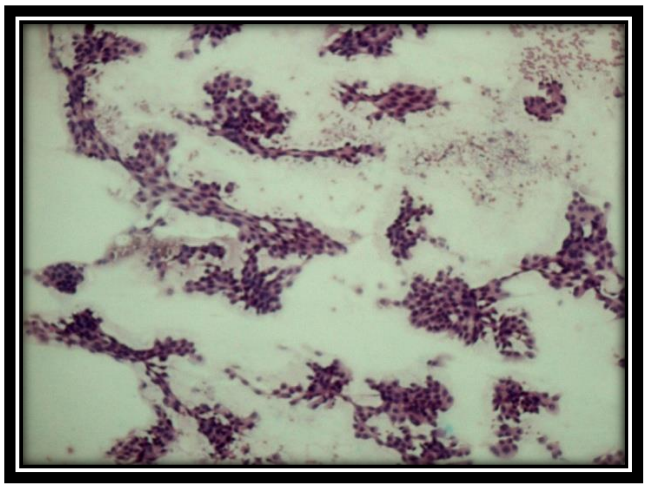
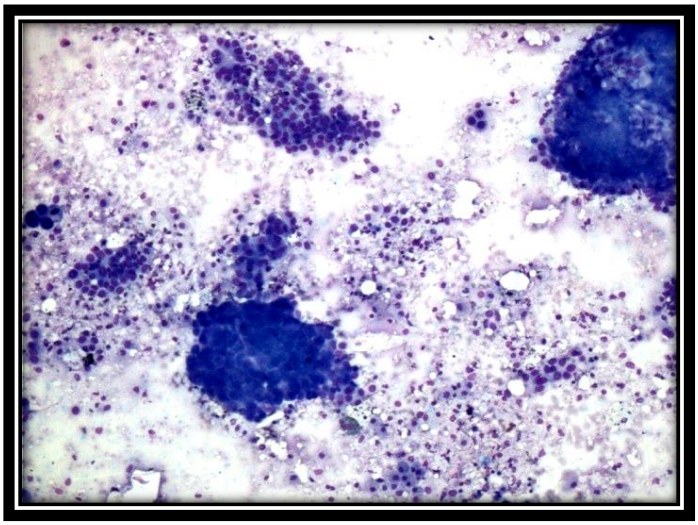
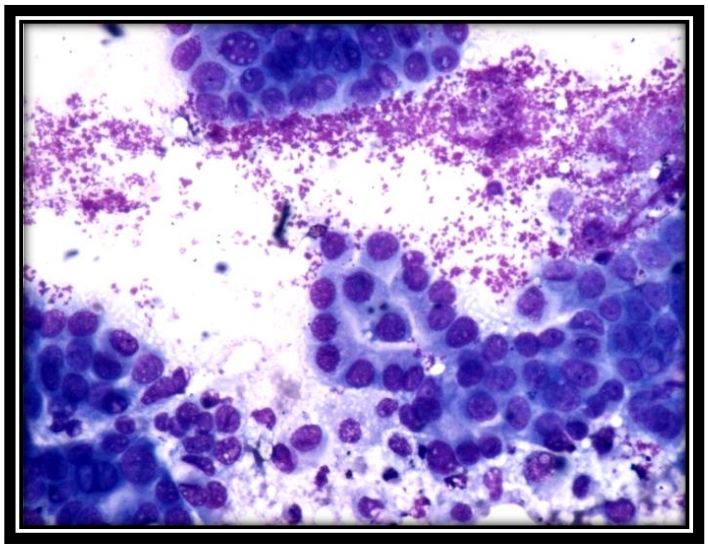


Photomicrograph 22: Brush smear showing Adenocarcinoma with cells arrangedin sheets, acini and papillaroid structure (Leishman Giemsa x 100)



Photomigrograph 23: FNA smear showing Adenocarcinoma(Leishman Giemsa x 100)



Photomicrograph 24: FNA showing Adenocarcinoma- large polyhedral cellsexhibiting glandular pattern with peripheral palisading (Leishman Giemsa x 400)

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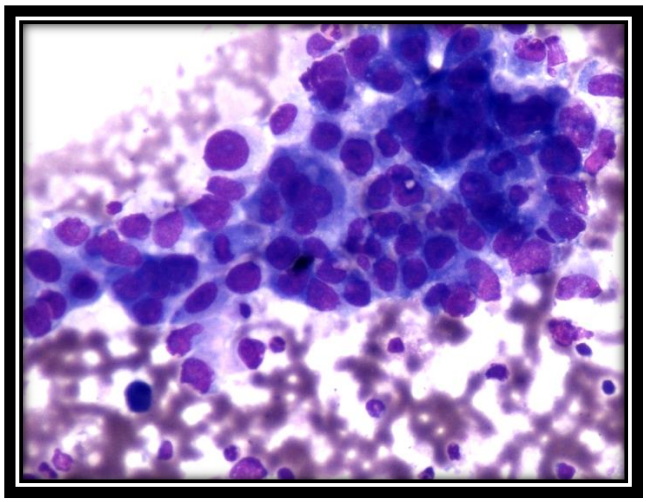
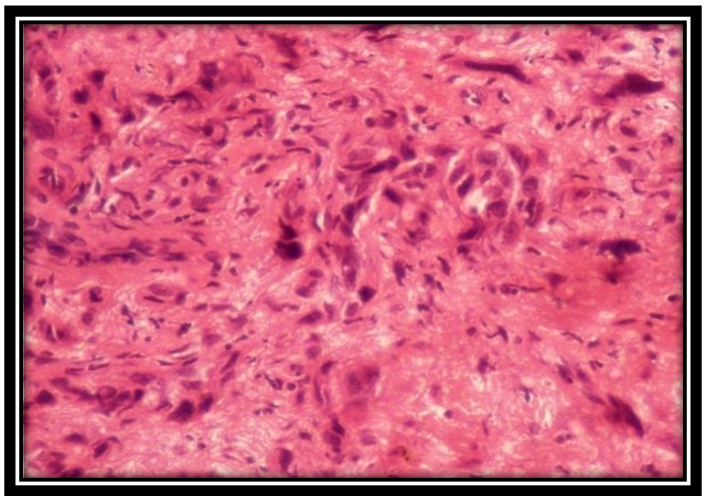
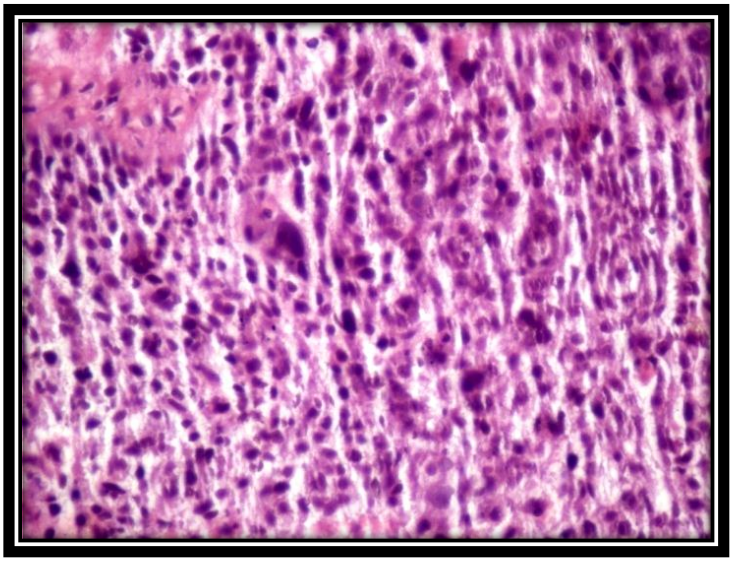


Photomicrograph 25: FNA smear showing Poorly differentiated large cell carcinoma lung (Leishman Giemsa x 400)



Photomicrograph 26: Biopsy showing Poorly differentiated carcinoma lung(H&E x 400)



Photomicrograph 27: Biopsy showing Non small cell carcinoma lung(H&E x 400)

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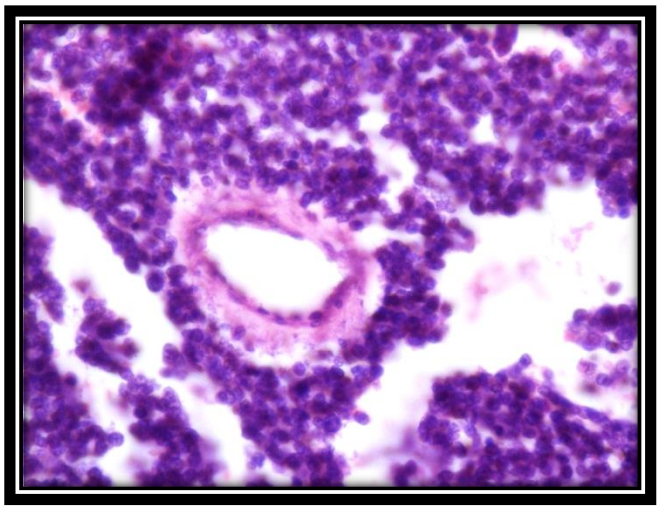
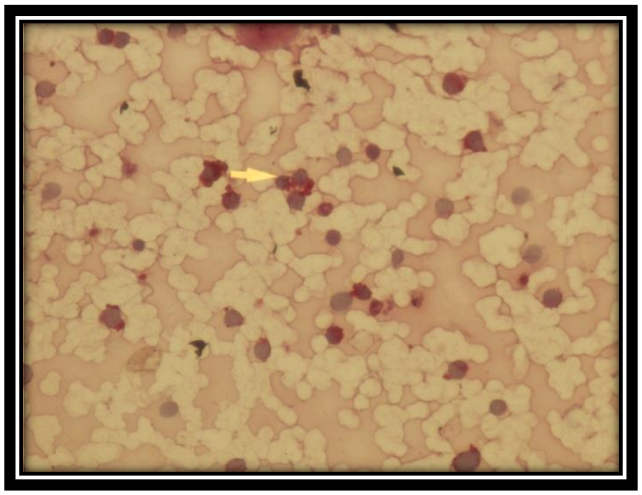


Photomicrograph 28: Biopsy showing metastatic small round cell tumor (Ewing's sarcoma) (H&E x 400)



Photomicrograph 29: FNA smear showing PAS positivity in Ewing's sarcoma (PAS x 400)

DISCUSSION

The present study was carried out in the Department of Pathology at Subharti Medical College, Meerutand associated Hospital, on cytological materials (bronchial brushing, bronchoalveolar lavage, and Fine needle aspirate) of the pulmonary lesions, collected and sent to the department of pathology by the clinical department. Different diagnostic modalities are available for diagnosis of pulmonary lesions but it has been suggested that a combination of various techniques may give the best results.[7]

Bronchoscopy and guided techniques have a definite role in the diagnosis of pulmonary lesions[8]. Fiberoptic bronchoscopy is the most common modality used to diagnose lung cancer. It is recognized as the best technique for obtaining specimens to diagnose endobronchial lung carcinoma.[9] Transthoracic fine needle aspiration cytology of small pulmonary lesions helps in earlier diagnosis, improved staging, increased chance of effective intervention and to formulate immediate effective management of pulmonary mass lesions.[10]The optimal combination of sampling techniques has not been finally established.[11]

In this study we evaluated the diagnostic accuracy of bronchoalveolar lavage and bronchial brushings obtained during bronchoscopic examination and transthoracic fine needle aspirates obtained under CT or ultrasound guidance. Relative diagnostic accuracy was also observed and correlated with bronchial biopsy wherever it was available.

The cytological material in our study included 135 (75.84%) bronchoalveolar lavage, 44 (24.72%) bronchial brush samples and 57 (32.02%) transthoracic fine needle aspirates. Most of the patients were in 4th to 7th decades of life with a mean of 57.8 years and a male to female sex ratio of 4:1. It was similar to the observation of Anupam Saha et al.[97] where the maximum number of cases was in 4th to 7th decades with the mean age of 56.8 years.

History of smoking in the present study was present in 108 males and 7 females (64.6%). Association of lung cancer with smoking was seen in 75.6% of cases. It has been noted that approximately 80%-85% of lung cancer deaths are attributed to smoking, strongest association being seen with squamous cell carcinoma.[12]In our study cough was the most common symptom (53%) followed by breathlessness and fever

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in 45% and 29% respectively. 21% patients presented with the complaint of hemoptysis. Similar observations were also seen in the study by Srivastava B et al.[13] where history of smoking was present in 77% of the cases; but cough was seen in 100%, fever in 47%, hemoptysis in 37%, breathlessness in 34%, chest pain in 36%, dyspnoea in 34% and hoarseness of voice in 5% of the cases respectively.

In the present study, 34.27% cases showed no lesions, while mucosal irregularity or inflammation and obvious growth were seen in 17.42% and 19.10% of cases respectively. Some of the cases also presented with vocal cord palsy and external compression. The main indication for bronchoscopy in our study was suspected pulmonary tuberculosis cases, others being suspected lung cancer. The confirmed diagnosis of tuberculosis in our series of patients was achieved in 29 cases. These cases were confirmed positive by Ziehl Neelsen stain which showed acid fast bacilli. Two of the cases had fungal infection. A total of 19 cases were diagnosed with lung cancer. This number was significantly low as compared to other studies probably because all the cases were included in the study irrespective of the clinical suspicion of carcinoma lung.

The overall sensitivity, specificity and accuracy of BAL in our study were 70.6%, 90.1% and 87.5% respectively. This was slightly higher than the results observed by Gaur DS et al.[14]in their study on efficacy of BAL in which the sensitivity, specificity and accuracy of BAL samples were 39.4%, 89.6% and 71.4% respectively. Bronchoalveolar lavage is a useful diagnostic tool in diffuse or disseminated lung malignancies that do not involve the bronchial structures visible by endoscopy. The neoplastic histotype and the intraparenchymal neoplastic growth pattern are good predictors for diagnostic yield.[15]The diagnostic yield for lung cancer in our series of patients was 18% which is very low as compared to the study by Srivastava B et al.[16] in which the diagnostic yield was 68%. Truong et al. (1985) reported sensitivity of 66%; while Ng. & Horak reported sensitivity as high as 74% for BAL.[17]

The BAL technique, including the total volume of saline instilled, varies widely among investigators and clinicians. Generally, 200 to 300 ml of saline is used to sample the sub segmental areas of the lung under investigation[18]. The volume of BAL received during this study was around 50 ml. This volume was low compared with the above stated optimal volume, considering a portion of the sample was divided in some fraction to allow both the microbiology and cytology departments to receive an amount adequate for processing and analysis. Perhaps these generally low volumes in turn lead to decreased diagnostic yields for the BAL procedures.

Another reason contributing to this low diagnostic yield for the diagnosis of carcinoma lung in our study may be attributed to the random selection of patients in comparison to the other studies where workers have included only those cases which were suspected clinically to be positive for carcinoma lung.

In the present study brushing was done in only 44 cases out of the total of 178 cases. Two cases were inadequate and they were excluded from the calculations. The number was low as there was no visible growth or ulceration on bronchoscopy. However, the sensitivity, specificity and the overall accuracy were 85.7%, 90.1% and 87.5% respectively. 19 cases were positive for malignancy. These results were similar with the findings of Gaur DS et al.[14] where the values of sensitivity, specificity and overall accuracy were 87.3%. 97.6% and 93.9% respectively. Bibbo et al.[19] reported the sensitivity of 70% and a specificity of 98% for brushings.

Total number of CT or ultrasound guided transthoracic fine needle aspiration was done in 57 cases out of which 41 cases revealed malignant cells, 9 were reactive, 4 were inadequate and 3 cases were suspicious for malignancy. Histopathological correlation was available in only five cases. The sensitivity, specificity and overall diagnostic accuracy were very high reaching up to 100% which may be due to small sample size for correlation. Similar results were observed in other studies by Anupam Saha et al.[20] (sensitivity of 94.7% and specificity of 96.5%), Shivani Kalhan et al.[21] (sensitivity of 92.2% and specificity of 100%). They concluded that TTFNA cytology is a low cost, safe, minimally invasive and accurate diagnostic procedure with high sensitivity and specificity. There are a large number of studies by various workers who consider FNA under guidance to be applied as the initial procedure in the diagnosis of peripheral malignant pulmonary lesions, rendering a high diagnostic yield with a low rate of complication.

Fine needle aspiration has emerged as an important tool used in the preoperative evaluation of solitary nodules of the lung. It provides with a definitive diagnosis in most of the patients at low cost with minimal trauma when assisted by modern imaging techniques and experienced personnel. False positive errors in this situation are often uncommon.[22] However, the question then of whether or not TTFNA should be the primary diagnostic tool becomes a complex one of balancing such considerations as length of a patient's hospital stay, economic factors and reluctance of some patients to permit their lungs to be pierced by needles.

The maximum numbers of cases were diagnosed as squamous cell carcinoma both on cytology and histopathology followed by small cell carcinoma and adenocarcinoma. This was similar to the observations of Saha Anupam et al.[20]and Gaur DS et al.[14]

There remains a debate as to whether a cytologic diagnosis of suspected lung lesion needs to be confirmed by biopsy? According to various authors, diagnostic utility of bronchial washings and brushings vary among different types of lung lesions, so a biopsy is required, however others have suggested

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that cytology should be considered for definite diagnosis and classification of lung cancers without the need for histopathologic confirmation.[11]

In those situations, in which cytologic-histologic correlation is not high, it should not be concluded that the cytologic interpretation is obviously an error and that the histologic interpretation is correct. But with age cytology has matured and it can now be appreciated that in some situations the cytologic interpretation may be just as correct as the tissue interpretation or, in some cases, more accurately reflective of the nature of the lesion than the tissue examined.[23]

CONCLUSION

TTFNA demonstrated the highest diagnostic accuracy, followed by bronchial brushings and BAL. Each method's effectiveness varies depending on the lesion type and location, emphasizing the importance of using multiple diagnostic modalities for pulmonary lesions.

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