Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 9, Issue, 11, pp.60567-60573, November, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

COMPARISON OF EFFICACY OF DIFFERENT DIAGNOSTIC MODALITIES OF LUNG CANCER: *BRONCHOSCOPIC METHODS (BAL, TBNA, EBLB), CT-FNAC, PLEURAL FLUID (ASPIRATION CYTOLOGY, PLEURAL BIOPSY), LYMPH NODE FNAC*

***Kapil Sharma, Vishal Patidar, Avinash Jain, Sheena Taneja, Sudan, D. P. S., Monica Sharma and Mishra, J. K.**

[1]Department of Pulmonary Medicine, SGT Medical College, Gurgaon
[2]Department of Pulmonary Medicine, Peoples College of Medical Sciences, Bhopal
[3]Department of TB and Respiratory Disease, Institute of Medical Sciences, Banaras Hindu University, Varanasi

ARTICLE INFO

Article History:
Received 07th August, 2017
Received in revised form
18th September, 2017
Accepted 21st October, 2017
Published online 30th November, 2017

Key words:

Bronchogenic carcinoma,
BAL,
Bronchoscopy,
CT guided FNAC.

ABSTRACT

Background: Bronchogenic carcinoma usually has fatal consequences but early diagnosis remains a challenge in developing nation like India. Bronchoscopic methods and CT guided FNAC are valuable tools for early diagnosis of both central and peripheral lesions.
Objectives: To compare the diagnostic efficacy of *Bronchoscopic methods (BAL, TBNA), Pleural Fluid (aspiration cytology, pleural biopsy), Lymph node FNAC* while considering *CT-FNAC of lung masses and EBLB* as Gold Standard tests.
Materials and Methods: Study was carried out for more than 4 years and various modalities of lung cancer were offered for CT diagnosed cases of lung masses. Data of 198 cases was recorded for statistical analyses.
Results: Study obtained higher sensitivity of BAL samples and Lymph node FNAC as 79.17% and 88.2 % respectively. However, there was low sensitivity of pleural fluid cytology and pleural biopsy as 26.4% and 11.11% respectively. The study recorded good specificity and accuracy for all the modalities.
Conclusion: We conclude to perform CT guided FNAC of masses, Bronchoscopic methods and lymph node FNAC for early detection of bronchogenic carcinoma.

Copyright©2017, Kapil Sharma et al. *This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.*

Citation: Kapil Sharma, Vishal Patidar, Avinash Jain *et al.* 2017. "Comparison of efficacy of different diagnostic modalities of lung cancer: *Bronchoscopic methods (BAL, TBNA, EBLB), ct-FNAC, pleural fluid (Aspiration cytology, Pleural biopsy), Lymph node FNAC*", *International Journal of Current Research*, 9, (11), 60567-60573.

INTRODUCTION

Lung cancer accounts for an estimated 1 million deaths each year (Spiro *et al*., 2002). The overall 5 year survival is approximately 15% (Ries *et al*., 1994). However, the survival rate may improve to 70% in some patients with resectable disease (Mountain CF *et al*., 1997) Bronchogenic carcinoma usually has fatal consequences, the diagnosis of which remains a challenge. However, metastasis to the mediastinal lymph nodes or thoracic organs and vessels are one of the most important factors in determining resectability and prognosis (Patterson *et al*., 1991). The overall diagnostic sensitivity of conventional bronchoscopic lung biopsy in these patients is reported around 57% (Chechani *et al*., 1996). The diagnostic yield depends on the number of samples obtained and the size of the lesion. It is also influenced by the combined use of sampling techniques such as forceps, washing, and needle aspiration. Flexible fiberoptic bronchoscope has now revolutionised the cytological diagnostic techniques like broncho alveolar lavage (BAL) and bronchoscopic brush cytology (Gaur *et al*., 2007). BAL specimen may also be used for molecular analysis as diagnostic and prognostic marker (Myron R Melamed *et al*., 2009). The pooled diagnostic sensitivity CT-guided transthoracic needle aspiration/biopsy is approximately 90% (Gouliamos *et al*., 2000). CT guided FNAC is particularly valuable in the diagnosis of lesions preferably located at the periphery of the lung. In India, lung cancer is rarely detected in early stages. Diagnosis at early stages where surgery could be offered is possibly a gift for the western world where new modifications of bronchoscopy (electromagnetic navigation, fluorescent bronchoscopy, EBUS assistance) are readily available. The present study aimed at evaluating the diagnostic efficacies of various easily available modalities in a developing nation like India where factors like medical facilities, cost affordability, misdiagnosis as

Corresponding author: **Kapil Sharma,**
Department of Pulmonary Medicine, SGT Medical College, Gurgaon

tuberculosis, and rural background pose a major hindrance in its early diagnosis. We compared the diagnostic efficacy of *Bronchoscopic methods (BAL, TBNA), Pleural Fluid (aspiration cytology, pleural biopsy), Lymph node FNAC* while considering *CT-FNAC and EBLB* as Gold Standard tests.

MATERIALS AND METHODS

The study was carried out in the department of TB and Respiratory Disease, Institute of Medical Sciences, Banaras Hindu University, Varanasi and Department of Pulmonary medicine, Peoples College of Medical Sciences, Bhopal. Out of all clinically and radio logically (CT scan) diagnosed cases of lung cancer received from June 2012 to Feb 2017(Four years & 8 months) i.e. 267 cases, we recruited 198 cases. Another important measure was to obtain a pre-intervention platelet count and coagulation profile. Biopsy and FNAC was not performed until all parameters were brought within normal limits. A written informed consent was taken from the patient, after explaining the entire procedure to the patients including the possible complications. Each subject was worked up and investigated according to the set protocol broadly categorized as follows:-detailed clinical history, examination and relevant investigations, X-ray chest (PA) view and lateral view, C.T. evaluation & CT guided FNAB/FNAC of lung masses, Bronchoalveolar lavage, Bronchoscopy guided endobronchial biopsy and Transbronchial Needle Aspiration of Mediastinal node (Subcarinal & Para tracheal node). Percutaneous pleural fluid aspiration for cytology and pleural biopsy were performed and FNAC of accessible peripheral lymph node. The cases with inadequate samples in any of the above mentioned modalities or lack of consent were considered for exclusion. Conventional flexible bronchoscopy was performed by attending pulmonologists under supervision using a standard therapeutic video bronchoscope. This had a 6.0mm diameter and 2.8mm working channel. All cases were performed under moderate sedation with fentanyl or midazolam, as well as topical 2% lidocaine. Transbronchial forceps (Olympus Endojaw FB-211D alligator cup forceps; Olympus, Tokyo, Japan) biopsy was performed for all cases in the targeted bronchopulmonary segment. The standard institutional practice is to obtain 4-6 biopsy specimens. However, bleeding and patient's inability to tolerate bronchoscopy prevented this standard from being achieved in some cases. Bronchoalveolar lavage sample is sent in sterile vials as 20ml aliquots of normal saline, samples centrifuged and smears are prepared. Biopsy specimens are sent in 10% formalin processed in routine tissue processor. CT guided FNAB/FNAC was done with 20G lumbar puncture needle. Aspirate is directly smeared over the slide and fixed in alcohol. Slides are stained with H&E, PAP and examined thoroughly for malignant cells (slides shown in Figure 1 & 2 respectively). The results of the smears were reported as: (a) Normal/ Negative for malignancy, (b) Inflammatory lesions,(c) Squamous metaplasia (d) Positive for malignancy (Ammanagi *et al*., 2012). Data is recorded for statistical analysis (Sensitivity, Specificity, Positive Predictive value, Negative Predictive value, Accuracy).

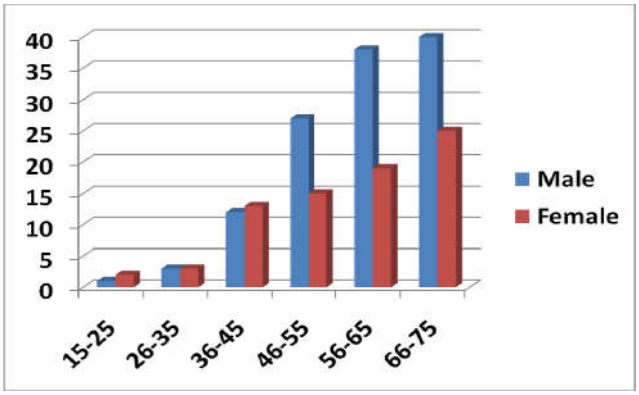
RESULTS

Demographic profile of intra thoracic masses

A total of 120 males (61.5%) and 78 females (38.5%), presented with intra thoracic masses (Diagnosed in CT Scan) were evaluated and underwent clinical, bronchoscopic evaluation along with BAL cytology & Bronchoscopic biopsy, Tran thoracic Needle aspiration cytology/Pleural Biopsy, ultrasound/CT guided FNAC or Biopsy . The male: female ratio was 1.55:1. The age range in either sex was 15 to 75 years. The age sex distribution of the patients revealed that maximum number of males belonged to the age group of 61-75 years (29%) and the maximum females in the age group of 61-75 yeas (16%) incidentally. The mean age of presentation of cases with intra thoracic masses is 61.96 ± 14.40. There is only 10% cases presenting with mass lesion below 40 years of age and only 2% of it was malignant in origin.

Table 1. Intra thoracic masses: Age and Sex distribution

Age group	Males		Females		Total	
	Cases	%	Cases	%	Cases	%
15-20	0	0	0	0	0	0
21-25	0	0	0	0	0	0
26-30	0	0	0	0	0	0
31-35	2	1	1	0.5	3	1.5
36-40	2	1	2	1	4	2
41-45	3	1.5	3	1.5	6	3
46-50	7	3.5	5	2.5	12	6
51-55	12	6	8	4	20	10
56-60	20	10	11	5.5	31	15.5
61-65	21	10.5	12	6	33	16.5
66-70	27	13.5	16	8	43	21.5
71-75	26	13	20	10	46	23
Total	120	60	78	38.5	198	100



Graph 1. Sex Distribution according to various ages

Smoking Habits

Among the 198 patients who were included in study, 134 patients (68%) were smokers and 64 patients (32%) were non smoker. Smoking habits was more common among males which comprises 94 of 120 males (78%), and there were 40 of 78(51%) female patients were smokers.

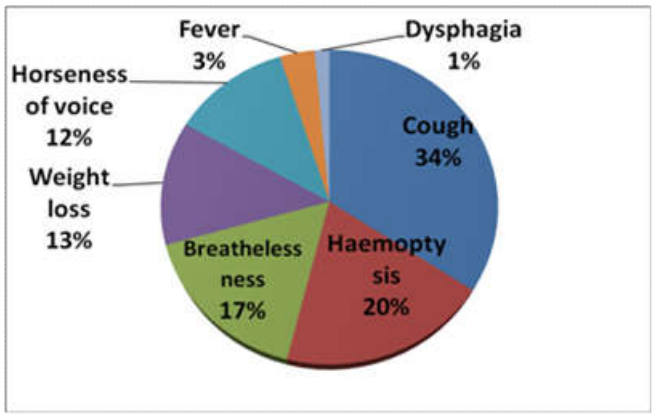
Socio economic status and background

Patients were grouped into rural and urban, and economically they are grouped into upper class, middle class and lower class according to their economic status (Kuppuswami scale). According to background most of the cases were from rural population comprising 67% (131/198). Also 66% (56/85) of the total malignancies were found in rural population whereas only 29 cases (34%) from the urban population. From the economic point of view lower, middle and upper class socio-economic strata grouped comprising 114 (57%), 72(36%) and 12(6%) respectively of the total cases. Lower class group registered highest percentage [62 %(53/85) of lung masses]

with malignant origin. The prevalence of lung masses with malignant origin in middle class and upper class was 33 %(28/85) and 5 % (4/85) respectively.

Clinical features

Cough was the predominant symptoms the study comprising 138 patients (70%) which is followed by haemoptysis 40 patients (40%). Symptoms like breathlessness, weight loss and chest pain was complained by 67 patients each (34%). Hoarseness of voice was seen in 47 patients (24%). The frequency of lung masses associated with fever was 7% (14 patients) and among the study group only 6 patients (3%) complained of dysphagia.



Graph 2. Lung masses : Showing the predominance of Symptoms

Intrathoracic masses: Diagnostic methods and test results

Of the 198 patients with intra thoracic masses, cases were divided according to *CT Findings* of:-

CENTRAL TUMOURS (Tumour within 3 cm of the hilar area) -96 cases -48.5 % (96/198)

PERIPHERAL TUMOURS (Tumour outside 3 cm of the hilar)-102 cases -51.5 % (102/198).

Bronchoscopy findings including *BAL cytology* were available in 104 patients (82-central + 22-peripheral), in 48 patients with intraluminal growth *bronchoscopy biopsies* were possible. *Transthoracic Needle aspiration cytology* was performed in all 98 cases of pleural fluid (23-central + 75-peripheral). 49 cases (16-central + 33-peripheral) out of 98 effusion pleural biopsy by *ABRAHM Pleural Biopsy Needle* could be performed. Thus out of 102 Peripheral Tumour cases, *CT Guided biopsy* could be done in 46 cases using gun biopsy device.

Intra thoracic masses: Bronchoscopic findings

In all the 104 cases (central-82 + peripheral-22) that underwent bronchoscopy, in 48 cases (24%) intraluminal growth was seen, whereas in 56 (28%) cases there were no growth visible. In 42 cases (21%) where growth was visualized, and 36 cases (18 %) where no growth has been seen malignancy was proved later on. Also of the remaining 94 cases where no bronchoscopy was performed, malignancy was confirmed histopathologically. No growth has been seen with the benign lesion in bronchoscopy. In 6 cases (3%) of cases where growth were seen bronchoscopically, 5 were tubercular and 1 case was inconclusive, proved in BAL cytology. And in 31(16%) where no growth were seen proper diagnosis could not be established with other modalities too.

Intra thoracic masses: BAL cytology

BAL cytology analysis were available in 104 cases (central-82 + peripheral-22), broncho-alveolar lavage cytology for malignancy was positive in 38 cases (19%) only. In 64 (32%) cases, BAL cytology was negative for malignant cells. In 10 cases (5%) later on proved to be of malignant cause.

Intra thoracic masses: *Percutaneous* CT Guided gun biopsy, Aspiration biopsy, Aspiration cytology:

46 underwent CT Guided gun biopsy & malignancy were proved in 38 (19%) cases, where as eight cases were of benign origin (tubercular mass (2 cases), hamartoma (3 case) and chronic pneumonitis (2 case)). In 1 case, it was inconclusive. Among the 98 patients of aspiration cytology (Peripheral Tumours-75 + Central Tumours-23), using 18-22 G needle, 9 cases reported to be of malignant origin whereas in 79 cases diagnosis was inconclusive. Ten cases were of benign origin of tubercular mass (6 case), Para pneumonic Effusion (4 case). Among the 98 patients, Pleural biopsy by ABRAHM"S NEEDLE was performed in 49 cases (Peripheral Tumours-33 + Central Tumours-16), 5 cases reported to be of malignant origin (one was considered false positive) whereas in 43 cases diagnosis were inconclusive. One case confirmed the diagnosis of Tubercular Effusion with Pleural Thickening. So diagnosis of 40% (80/198) of total cases were considered malignant by Gold Standard tests (42-bronchial biopsy, 38-CT guided biopsy) and 5% (10/198) were of benign origin, whereas in 55% (108/198) diagnosis could not be made out, considering GOLD Standard Tests. In all the three cases of benign lung mass (HEMARTOMA), proved by CT Guided core biopsy, there were no lymphadenopathy.

Palpable lymph nodes

Lymph nodes were palpable in 57 patients, mainly supraclavicular or mediastinal. For mediastinal group of lymph nodes, transbronchial needle aspiration (TBNA) was done, but accessed from paratracheal or subcarinal group of lymph nodes. Supraclavicular or axillary lymph nodes were palpable in 37 patients (18 %) and mediastinal lymph nodes seen in 20 patients (10%). Additionally, FNAC of the supraclavicular lymph nodes (Transcutaneous route) or mediastinal lymph nodes (Trans bronchial route) of 47 cases was possible which showed malignancy in 34 cases (of which 30 cases confirmed by Gold standard Tests), tuberculosis in 3 case, pneumonitis in 2, whereas in 8 cases it was inconclusive. Additional 4 detected cases were Hodgkin's lymphoma (2 cases), non Hodgkin's lymphoma (1 case) and plasmacytoma (1 case). So overall malignant cases by histopathology (GOLD Standard Tests) or lymph node cytology was 42 % (84/198).

Histopathological and Cytological diagnosis (Table 2)

The majority of the neoplasms were squamous cell carcinomas, followed by small cell carcinomas and adenocarcinomas.

Complications

Complications encountered during above procedures were development of pneumothorax in 10 cases accounting for 5%

of the whole cases. Pneumothoraxes were minor and asymptomatic in 8, only 2 cases required chest tube placement. Minimal haemoptysis developed in the form of blood-tinged sputum in only three cases apart from minor complications like local pain and ecchymosis.

Comparison of Diagnostic Modalities

a) Test characteristics of single diagnostic modalities

The findings of BAL cytology, lymph node biopsy and aspiration cytology and Pleural biopsies of lung masses were compared using standard formulae to arrive at the test characteristics. The following criteria were used for calculating the various test results.

True Positive : Malignant + indeterminate test results proved histologically malignant.
True negative : Benign test results proved histologically benign
False Positive : Malignant + indeterminate test results proved histologically benign.
False negative : Benign test results proved histologically malignant.

The summary of various test characteristics of single diagnostic modalities is shown in table (3-5) and depicted by graph (3-5) above. It is clear that when used alone, sensitivity and specificity of BAL cytology for malignant cells are 79.17% and 96.4% respectively. Specificity of pleural biopsy and TTNA is 95% and 92.3% respectively, sensitivity and specificity of FNAC lymph node for malignant cells are 88.2% and 69.2% respectively. Accuracy rate of TTNA and FNAC Lymph node is 71 % and 82.9 % respectively, while accuracy of BAL cytology for malignant cells is 88.46 %.Sensitivity is low for pleural fluid cytology & pleural biopsy as 26.4% and 11.11% respectively.

Comparison of Multiple diagnostic modalities

The combination of four diagnostic modalities i.e. BAL cytology, percutaneous lung biopsy, bronchoscopy and lymph node FNAC was studied. The combination of all of these investigative modalities made available the diagnosis of malignancy in 84 cases.

Table 2. Prevalence of various histopathological diagnosis through different diagnostic modalities

S.No.		Histopathology	Bronchoscopic biopsy	Bal cytology	Core biopsy (CT guided)	Aspiration cytology	Pleural biopsy	FNAC Lymph Node
1	MALIGNANT	Squamous cell carcinoma	15	13	6	2(-9)		6
2		Small cell carcinoma	10	9	2	1(-7)	1(+1)	5(-1)
3		Adeno carcinoma	8	5	10	2(-5)	1	6(-2)
4		Adeno squamous	2	3(+1)	4	1(-2)		2
5		Large cell carcinoma			1			2
6		Broncho alveolar carcinoma	3	3	1	0(-1)		0(-1)
7		Poorly differentiated Carcinoma	3	4(+1)	3	1(-1)	1	2
8		Mesothelioma		0	3	1	2	0
9		Anaplastic non-small cell carcinoma		2	2			1
10		Hodgkin's lymphoma	0	0	3	1(+1)		5(+2)
11		Non-Hodgkin's lymphoma	1	1	3			4(+1)
12		Plasmacytoma						1(+1)
13	Hamartoma (benign)			0	3	0		0
14	INFECTION	Chronic Pneumonitis		13	2	4		2
15		Tuberculosis	5	23	2	6(+2)	1	3
16	Inconclusive		1	38	1	79	43	8
17	Total		48	104	46	98	49	47

RED colour indicates the gold standard test used
FALSE POSITIVE reports are indicated by (+) sign
FALSE NEGATIVE reports are indicated by (-) sign

Table 3. Central tumours (n=92)

	True Positive	True negative	False positive	False negative
BAL Fluid	28	47	1	6
TTNA	1	9	1	12
Pleural Biopsy	1	2	0	13
FNAC lymph	18	4	2	3

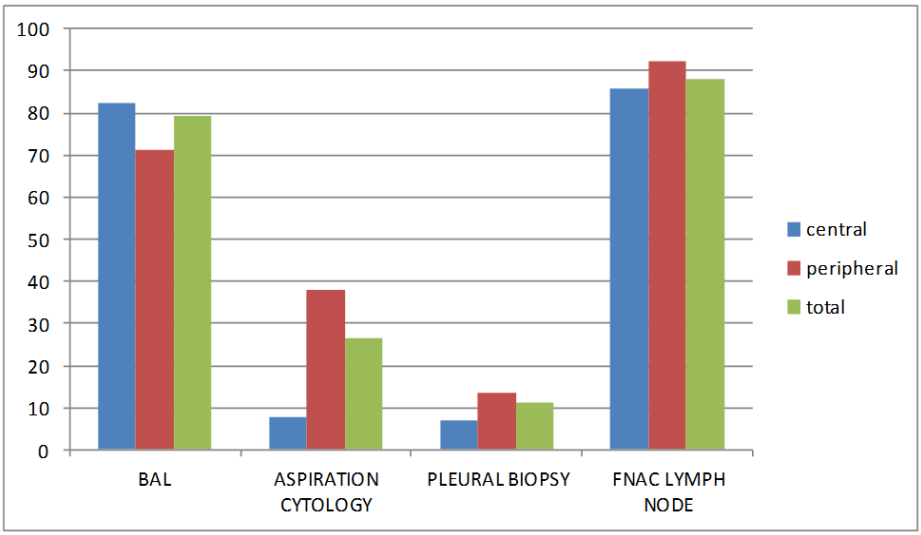
Table 4. Peripheral Tumours (n=106)

	True positive	True negative	False positive	False negative
BAL Fluid	10	7	1	4
TTNA	8	52	2	13
Pleural biopsy	3	10	1	19
FNAC lymph	12	5	2	1

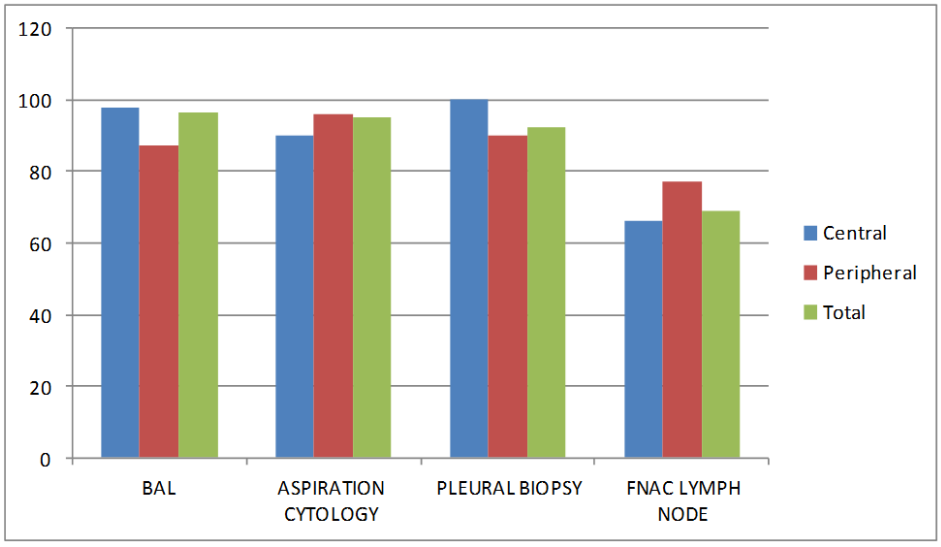
Table 5. Single diagnostic modalities

Test character Istics	BAL (n=104) 82 central 22 peripheral	Pleural fluid cytology (n=98) 23 central 75 peripheral	Pleural biopsy (n=39) 16 central 33 peripheral	FNAC Lymph node(n=47) 28 central 19 peripheral
Sensitivity	82.35 % (C)	7.6 % (C)	7.14 % (C)	85.7 %(C)
	71.42 % (P)	38.1 % (P)	13.6 % (P)	92.3 %(P)
	79.17 (T)	26.4% (T)	11.11 %(T)	88.2 %(T)
Specificity	97.9 % (C)	90 %(C)	100 %(C)	66 % (C)
	87.5 % (P)	96 %(P)	90 %(P)	77.4 %(P)
	96.4 %(T)	95 %(T)	92.3 %(T)	69.2 %(T)
Positive predictive value	96.55 %(C)	50 %(C)	100 %(C)	90 %(C)
	90.9 %(P)	80 %(P)	75 %(P)	86 %(P)
	95 %(T)	75 %(T)	80 %(T)	88.2 %(T)
Negative predictive value	88.68 %(C)	42.8 %(C)	8 %(C)	57.14 %(C)
	63.64 %(P)	80 %(P)	34.4 %(P)	83.3 %(P)
	84.38 %(T)	71 %(T)	27.3 %(T)	69.2 %(T)
Accuracy rate	91.46 %(C)	43 %(C)	18.75 %(C)	81.5 %(C)
	77.27 %(P)	80 %(P)	39.4 %(P)	85 %(P)
	88.46 %(T)	71 %(T)	32.65 %(T)	82.9 %(T)

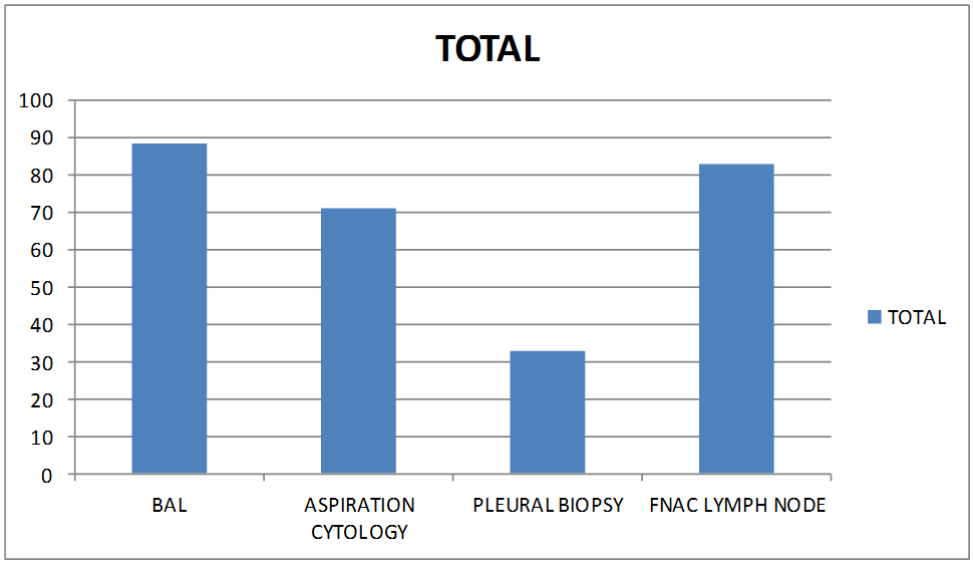
C-Central P-Peripheral T-Total



Graph 3. SENSITIVITY pattern of single diagnostic modalities



Graph 4. SPECIFICITY pattern of single diagnostic modalities



Graph 5. ACCURACY of single diagnostic modalities

DISCUSSION

In present study, majority of cases of bronchogenic carcinoma are from elderly males (>60 years) from rural background with a chronic history of smoking. The presenting symptoms are predominantly cough, haemoptysis and breathlessness followed by others. The cell types isolated were majorly squamous cell carcinoma followed by adenocarcinoma and other cell types, which goes in accordance with the data published in various Indian studies. The advent of flexible fiberoptic bronchoscope has lead to new turn in Pulmonology as samples like lavage, washings, brush smear, transbronchial needle aspiration and biopsy can be collected from the respiratory tract (Johnston *et al*., 1997). Cytological sampling by BAL relies mainly on cells exfoliated from malignant lesion in bronchial epithelium. Evaluation of CT Bronchus sign (Ernst *et al*., 2010) and CT directed FNAC has the advantage of precise sampling from the lesion. With good sensitivity, CT FNAC promises to be a convenient cytological technique that can be confidently utilized for screening and early diagnosis of lung cancer thereby saving the time needed for the processing of the biopsy specimens (Wongsurakiat P *et al*., 1998). Therefore our study used CT FNAC or histopathology of tissue specimens obtained from Endobronchial Biopsy (EBLB) as the gold standard test for evaluating the diagnostic efficacy of other available modalities (Bronchoalveolar lavage, Bronchoscopy guided Transbronchial Needle Aspiration of Mediastinal node (Subcarinal & Para tracheal node), Percutaneous needle aspiration of pleural fluid for cytology and pleural biopsy and FNAC of Peripheral lymph node). In our study, sensitivity and specificity of BAL samples is 79.17% and 96.4% respectively, which is comparable to other studies such as that (Jay *et al*., 1980) with 63%, (Sing *et al*., 1997) with 50% sensitivity. Wongsurakiat *et al* found that the diagnostic yield of BAL is influenced by the size and segmental location of the lesion. Bronchoscopy having a higher sensitivity of 84.2% and specificity of 100% is being recorded in previous studies also (Anastasia De Roza *et al*., 2016). Pleural metastases are seen more common in the visceral pleura (Rodrîguez-Panadero *et al*., 1989) and tend to be focal when there is involvement of the parietal pleura. Therefore pleural fluid cytology and pleural biopsy adds to the available diagnostic tools for lung masses. Studies examining the diagnostic yield for malignancy of pleural cytology (Garcia *et al*., 1994; Bielsa *et al*., 2008) have reported a mean sensitivity rate of about 72% (range, 49%-91%), higher when at least two pleural fluid specimens are submitted. Pleural fluid cytology in our sample had specificity 95%. The sensitivity was lower (26.4%) because of higher false negative reports due to single specimens taken.

Biopsy specimens of pleura can be obtained via blind or closed percutaneous needle biopsy, image-guided needle biopsy, medical thoracoscopy, or video-assisted thoracoscopic biopsy. Various meta-analysis of closed pleural biopsies performed using the Abrams needle reported a diagnostic yield for malignancy of only 57% (Tomlinson *et al*., 1987). The diagnostic yield for detection of malignancy increased by 7% to 27% over the yield of pleural fluid cytology (Nance *et al*., 1991). Our sample population has sensitivity 11.11% and specificity 92.3%. The lower sensitivity was attributed due to blind technique employed in all our samples, neither VAT nor USG guidance was used. FNAC was taken from mediastinal lymph node by TBNA technique or aspiration was done from peripheral lymph node blindly/USG guidance. Sensitivity in our sample population was 88.2%. This goes in accordance with previous studies where the median sensitivity of TBNA not using real-time radiological needle guidance was 82% (Wang *et al*., 2002; Patelli *et al*., 2002; Katis *et al*., 1998). Use of single specimens for pleural fluid cytology and blind pleural biopsy is the limitation of our study leading to lower sensitivity of pleural fluid cytology and pleural biopsy. However, the strength of our study included enrollment of larger sample size of 198 patients from 2 centers. Also we included most of the available diagnostic modalities (Bronchoalveolar lavage, Bronchoscopy guided Transbronchial Needle Aspiration of Mediastinal node (Subcarinal & Para tracheal node), Percutaneous needle aspiration of pleural fluid for cytology and pleural biopsy and FNAC of Peripheral lymph node).

Conclusion

CT FNAC, Bronchoscopy modalities (TBNA, BAL and EBLB) and lymph node FNAC are good diagnostic modalities, which can be combined together in a single patient to help in the early diagnosis and morphological classification of lung cancer in a poor country like India. Pleural fluid cytology and

pleural biopsy have low sensitivity thereby missing cases both in early and advanced stages of lung cancer.

Acknowledgment

We would like to thank the entire staff of Pulmonary Medicine department (Peoples hospital, Bhopal and Sir Sundarlal hospital, Varanasi) for their constant support & help. Special thanks to all the patients for their valuable contribution to this study.

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethics approval and consent to participate: Written informed consent was obtained from all the patients. The study was approved by the Institutional Ethical Committee.

Abbreviations

CT: Computed tomography; BAL: Bronchoalveolar lavage; EBLB: Endo-bronchial lung biopsy; EBUS: Endobronchial Ultrasound; FNAC: Fine Needle Aspiration Cytology; FNAB: Fine Needle Aspiration Biopsy; TBNA: Transbronchial Needle Aspiration; H & E**:** Hematoxylin and Eosin; PAP: Papanicolaou Stain.

REFERENCES

Ammanagi AS, Dombale VD, Miskin AT, Dandagi GL, Sangolli SS. 2012. Sputum cytology in suspected cases of carcinoma of lung (Sputum cytology a poor man's bronchoscopy!).Lung India, 29:19-23.

Anastasia De Roza, Kien Hong Quah, Cheong Kiat Tay, Weiquan Toh, HuiHua Li, Ganesh Kalyanasundaram, and Devanand Anantham. 2016. Diagnosis of Peripheral Lung Lesions via Conventional Flexible Bronchoscopy with Multiplanar CT Planning Marianne. *Hindawi Publishing Corporation Pulmonary Medicine*, Article ID 5048961, 7 pages

Bielsa S, Panadés MJ, Egido R, *et al*. 2008. Accuracy of pleural fl uid cytology in malignant effusions [in Spanish] . *An Med Interna*., 25 (4): 173 - 177.

Chechani, V. 1996. "Bronchoscopic diagnosis of solitary pulmonary nodules and lung masses in the absence of endobronchial abnormality," *Chest*, vol. 109, no. 3, pp. 620–625.

Ernst and D. Anantham, 2010. "Bronchus sign on CT scan discovered," *Chest*, vol. 138, no. 6, pp. 1290–1292.

Garcia LW, Ducatman BS, Wang HH. 1994. The value of multiple fl uid specimens in the cytological diagnosis of malignancy. *Mod Pathol*., 7 (6): 665 - 668.

Gaur DS, Thapliyal NC, Kishore S, Pathak VP. 2007. Efficacy of bronchoalveolar lavage and bronchial brush cytology in diagnosing lung cancers. *J Cytol*., 24:73-7.

Gouliamos AD, Giannopoulos DH, Panagi GM, Fletoridis NK, Deligeorgi-Politi HA, Vlahos LJ. 2000. Computed tomography-guided fine needle aspiration of peripheral lung opacities. An initial diagnostic procedure?. *ActaCytol*., 44:344 -8.

Jay SJ, Wehr K, Nicholson DP, Smith AL. 1980. Diagnostic sensitivity and specificity of pulmonary cytology: comparison of techniques used in conjunction with flexible fibre optic bronchoscopy. *ActaCytol*., 24:304-12.

Johnston WW, Elson CE. 1997. Respiratory tract. In: Bibbo M, editor. Comprehensive cytopathology, 2nd ed. Philidelphia: W. B. Saunders company; p. 325-401.

Katis K, Kotrogiannis G, Paraskevopoulos I, *et al*. 1998. Bronchoscopic needle aspiration in mediastinal staging of patients with bronchogenic carcinoma. *J Bronchology*., 5:195–9.

Mountain CF. 1997. Revisions in the international system for staging lung cancer. Chest, 111:1710–7.

Myron R Melamed, Leopard G Koss. 2009. Tumors of Lung. In: Myron R Melamed, Leopard G Koss, editor.Koss' diagnostic cytology and its histopathological bases, 5th ed.Philadelphia: Lippincott Williams & Wilkins; p. 645-706.

Nance KV, Shermer RW, Askin FB. 1991. Diagnostic effi cacy of pleural biopsy as compared with that of pleural fl uid examination . *Mod Pathol*., 4 (3): 320 - 324 .

Patelli M, Lazzari L, Poletti V, *et al*. 2002. Role of fiberoptic transbronchial needle aspiration in the staging of N2 disease due to non-small cell lung cancer. *Ann Thorac Surg*., 73:407–11.

Patterson GA. 1991. Surgical techniques in the diagnosis of lung cancer. *Chest*, 100:523–6.

Ries LAG. 1994. Influence of extent of disease, histology and demographic factors on lung cancer survival in the SEER population-based data. *Semin Surg Oncol*., 10:21–30.

Rodrîguez-Panadero F, Borderas Naranjo F, López Mejîas J. 1989. Pleural metastatic tumours and effusions. Frequency and pathogenic mechanisms in a post-mortem series. *Eur Respir J*., 2 (4): 366 - 369.

Sing A, Freudenberg N, Kortsik C, Wertzel H, Klosa B, Hasse J. 1997. Comparison of the sensitivity of sputum and brush cytology in the diagnosis of lung carcinomas. *ActaCytol*., 41:399-408.

Spiro SG, Porter JC. 2002. Lung cancer - where are we today? Current advances in staging and nonsurgical treatment. *Am J Respir Crit Care Med*., 166:1166–96.

Tomlinson JR, Sahn SA. 1987. Invasive procedures in the diagnosis of pleural disease . *Semin Respir Med.,* 9 (1): 30 - 60.

Wang R, Han JJ, Yao J, *et al*. 2002. [The role of transbronchial needle aspiration in the staging of bronchogenic carcinoma]. Zhongguo fei ai za zhi. *Chinese Journal of Lung Cancer*, 5:284–6.

Wongsurakiat P, Wongbunnate S, Dejsomritrutai W, Charoenratanakul S, Tscheikuna J, Youngchaiyud P. 1998. *et al*. Diagnostic value of bronchoalveolar lavage and postbronchoscopic sputum cytology in peripheral lung cancer. *Respirology*, 3:131-7.

****