Section: Respiratory Medicine

Original Research Article

TO STUDY THE DIAGNOSTIC YIELD OF PERIPHERALLY LOCATED LUNG MASS LESIONS BY TRANSTHORACIC ULTRASOUND-GUIDED BIOPSY BY USING COAXIAL NEEDLE: A CROSS-SECTIONAL STUDY

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Abstract

Background: Pulmonary lesion diagnosis is challenging, with sputum examinations for infective lesions and interventional procedures for mass lesions. Advanced computerized tomography and ultrasound-guided biopsies are used for peripheral lung mass lesions. Hence, the main aim is to study the diagnostic yield of peripherally located lung mass lesions by transthoracic ultrasound-guided biopsy using a coaxial needle. **Materials and Methods:** This cross-sectional study was conducted at Rajiv Gandhi Government General Hospital, Chennai, for 12 months (November 2020 to October 2021) on 66 patients with peripherally located lung mass lesions. The data collected from the patients included their name, age, sex, occupation, and a detailed history of clinical symptoms, such as a history of cough with or without expectoration, difficulty in breathing, hemoptysis or blood-stained sputum, chest pain, loss of weight and appetite, as well as any other reported symptoms. **Result:** A study of 66 patients found that 62 were lung mass, 2 were mediastinal mass, and 2 were pleural mass. Most cases were male, with mediastinal lymphoma being the most common. Most patients reported cough, weight loss, chest pain, and loss of appetite. Shortness of breath was common, and 27.3% had hemoptysis. The USG-guided Bx yield was compared with the final report using the receiver operating characteristic curve, revealing a sensitivity of 98.4%, specificity of 75%, PPV of 98.4%, and NPV of 75%. There is no statistical significance between lesion size and the final report, but there is a statistical significance between lesion size and post-procedure complications. **Conclusion:** The study found that USG-guided lung biopsy offers high accuracy, good diagnostic yield, and minimal complications.

INTRODUCTION

Evaluating patients presenting with pulmonary lesions is hard; for suspected infective lesions, a sputum examination will give an idea to arrive at the diagnosis. However, for mass lesions, interventional procedures were necessary to arrive at a diagnosis.[1] In the current era, the development of advanced computerised tomography will give the exact size and area of involvement, and for centrally located mass lesions, bronchoscopy, ultrathin bronchoscopy, electromagnetic navigational bronchoscopy & endobronchial ultrasound will be useful to inspect and do further procedures.[2,3] But for peripherally located lung mass lesions, we need to investigate by doing guided biopsies with either CT-guided or ultrasound-guided. For any mass lesions, tissue biopsy and histopathological examination are the gold-standard techniques for the final diagnosis.

CT was commonly used for initial detection & further disease progression or regression following treatment. It is also an expensive mode of investigation, which may not be available in a few rural hospitals and causes high radiation exposure.[4] Frequent use of CT may even cause much more radiation exposure. In those circumstances, ultrasound is a good alternative for CT-guided procedures, which don't use radiation exposure and are also readily available in almost all setups, even in peripheral hospitals.[5,6] Peripheral lung mass lesions were assessable not only by CT but also by USG. The only thing needed is adequate training for healthcare professionals to do ultrasound-guided biopsies for peripheral lung mass lesions. Followed by biopsy,

histopathological examination and Immunohistochemistry study is essential to give the correct treatment regimen if malignancy is confirmed. USG-guided biopsies also cause less post-procedural complications.[7,8]

Although experienced pulmonologists can often diagnose the type of lung cancer based on clinical presentation with radiographic appearance, an adequate tissue sample is definite to conclude the diagnosis and plan treatment.[9] Molecular testing requires a significant amount of tissue. Targeted therapies can increase treatment options for patients with advanced disease or poor functional status. Various diagnostic methods are available that yield cytology samples or small biopsies. The choice of procedure depends on the location, type & size of the tumour, comorbidities, and accessibility of metastasis.[7,10,11] In general, the least invasive method possible should be chosen. Further invasive methods will be required if the procedure fails to obtain tissue. Hence, the main aim is to study the diagnostic yield of peripherally located lung mass lesions by transthoracic ultrasound-guided biopsy using a coaxial needle.

MATERIALS AND METHODS

This cross-sectional study was conducted at Rajiv Gandhi Government General Hospital, Chennai, for 12 months (November 2020 to October 2021) on 66 patients with peripherally located lung mass lesions, accessible by ultrasonogram, who were admitted to the Department of Thoracic Medicine. Ethical committee approval and informed consent were obtained before the study started.

Inclusion Criteria

Patients with peripherally located lung mass lesions in the CECT Chest and patients willing to participate in the study and give informed written consent were included.

Exclusion criteria

Patients with centrally located lesions, patients with lung lesions with high vascularity, patients with a high risk of getting pneumothorax, and patients with coagulopathies were excluded.

The data collected from the patients included their name, age, sex, occupation, and a detailed history of clinical symptoms, such as a history of cough with or without expectoration, difficulty in breathing, hemoptysis or blood-stained sputum, chest pain, loss of weight and appetite, as well as any other reported symptoms. Additionally, the patient's history of chronic illnesses was documented, which encompassed conditions like diabetes mellitus, systemic hypertension, chronic kidney disease, coronary artery disease, chronic lung diseases such as bronchial asthma, chronic obstructive pulmonary disease, interstitial lung disease, and post-pulmonary tuberculosis sequelae, as well as any history of malignancy or other comorbid conditions.

Furthermore, the patient's personal history with regards to smoking was recorded according to CDC guidelines, categorising them as current smokers (those who had smoked more than 100 cigarettes in their lifetime and currently smoke every day or some days), former smokers (those who had smoked more than 100 cigarettes in their lifetime but do not currently smoke), and never smokers (those who have not smoked 100 cigarettes in their lifetime).

Occupational history was also meticulously documented, including details on the duration and nature of their work, to explore any potential associations between their clinical presentation and occupation. Additionally, the patient's family history was recorded, particularly focusing on any history of malignancy in blood-related family members. Finally, imaging studies were conducted to assess further and diagnose the patient's conditions.

Chest X-ray is the first mode of investigation for all cases with prolonged respiratory complaints, which is very basic and simple to rule out chest pathologies. All cases were used for whole thoracic CT examination. All non-contrast scans were acquired in volumetric mode, and scanning was done from the thoracic inlet to the upper abdomen. Patients are asked to lie supine in deep inspiration with arms extended overhead to reduce beam hardening artefacts.

The acquired CT images were reconstructed into soft tissue mediastinal window (20-30 kernel), lung window (in sharp algorithm, 60-80 kernel), and 1.2 - 1.5 mm section thickness for interpretations. Every chest CT examination was read first by one radiologist, and then another radiologist checked the report.

According to inclusion criteria, all eligible patients were assessed by ultrasonogram to conclude the feasibility of undergoing USG-guided biopsy. Those who were feasible by USG-guided biopsy were posted for the procedure, and post-procedure complications were monitored.

Statistical Analysis

All the data were entered into MS Excel and expressed as frequency and percentage. Pearson's Chi-Square test was used to compare the two variables. A p-value <0.05 was considered as a statistical significance.

RESULTS

Among 66 patients, 62 were lung mass, 2 were mediastinal mass & 2 were pleural mass patients. Gender involvement in females was 13.6%, the male was 86.4%, and predominant involvement was seen in the male population. Age distribution of < 20 years was 3%, 21-35 years was 6.1%, 36-50 years was 21.2%, 51-65 years was 42.4%, and >65 years was 27.3%. Hence, the predominant presentation in the age group between 51-65 years. Among 66 cases, patients less than 20 years of age had mediastinal

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lymphoma, and others had primary lung carcinoma or metastasis.

Most patients complained of cough, which was 78.8%, followed by weight loss, which was seen in 71.2%, chest pain at 51.5%, and loss of appetite at 43. Shortness of breath was seen in 68.2% (16.7% had grade 1, 25.8% had grade 2, 22.7% grade 3, and 3% had grade 4 MMRC). Haemoptysis present was 27.3%, and 4.5% of patients had no respiratory symptoms.

3% had bronchial asthma, 12.1% had emphysematous lung disease (all had a history of chronic smoking), 3% had Interstitial lung disease, and 15.2% had a history of prior pulmonary tuberculosis treatment [Table 1].

More than 2/3 of the samples were smokers. Location of the mass distribution where the lung was 93.9%, mediastinal was 3%, and pleural was 3%. Most patients presented with T3, T4 Stage only < 4 cm mass seen in 6.1% of patients, 4-5 cm in 16%, 5-7 cm in 36.4%, and >7 cm in 47%. 19.7% of patients had malignant Pleural Effusion, and 31.8% had Chest wall invasion by the mass.

Pleural Effusion distribution was present in 19.7%, and chest wall invasion in 31.8%. The radiological appearance of the mass-dense appearance is the predominant distribution, which gives a good yield also. USG-guided Biopsy yield was 93.9%, and 92% had no complications.

Final report distributions were Infection/Inflammation at 1.5%, adenocarcinoma at 39.4%, Squamous cell carcinoma at 27.3%, Small cell carcinoma at 7.6%, Large cell carcinoma at 4.5%, Sarcomatoid carcinoma at 4.5%, metastasis was 6.1%, lymphoma was 3%, Inconclusive was 6.1% [Table 2].

Comparison of USG guided Bx yield with the final report using receiver operating characteristic curve (RoC), which shows the area of the curve is 0.867, p-value= 0.014 <0.05 with 95% C.I 0.611 to 1.000, statistical significance with the sensitivity was 98.4%, Specificity 75%, PPV 98.4%, NPV 75% and accuracy 97% [Table 3 and Figure 1].

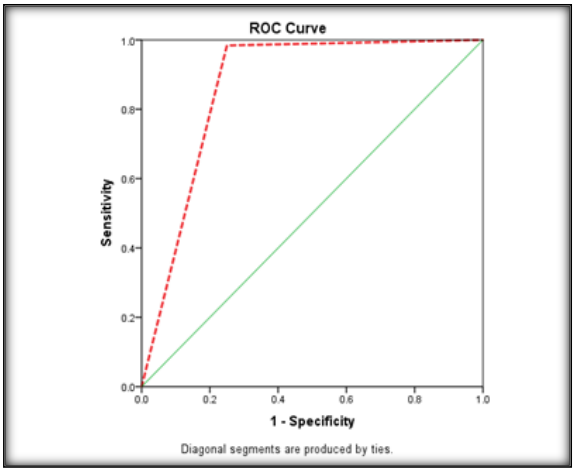

Figure 1: USG guided Bx yield with Final report accuracy using Receiver Operating

Comparison of the lesion size with the final report shows $\chi 2=0.936$, $p=0.817$, >0.05, which shows no statistical significance with the size of the lesion and final report. Comparison of the lesion size with post-procedure complications shows $\chi 2=32.954$, $p=0.0001$, <0.01, which shows high statistical significance with the lesion size and post-procedure complications [Table 5].

Table 1: Demographic data of the study

		Frequency	Percentage
Gender	Female	9	13.6
	Male	57	86.4
Age group (years)	Up to 20	2	3
	21 - 35	4	6.1
	36 - 50	14	21.2
	51 - 65	28	42.4
	Above 65	18	27.3
Clinical presentation			
Asymptomatic	Present	3	4.5
	Absent	63	95.5
Cough	Present	52	78.8
	Absent	14	21.2
Chest pain	Present	34	51.5
	Absent	32	48.5
LOW	Present	47	71.2
	Absent	19	28.8
LOA	Present	29	43.9
	Absent	37	56.1
Hemoptysis	Present	18	27.3
	Absent	48	72.7
SOB	Nil	21	31.8
	1	11	16.7
	2	17	25.8
	3	15	22.7
	4	2	3
Prior respiratory comorbidities			
BA	Present	2	3

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	Absent	64	97
COPD	Present	8	12.1
	Absent	58	87.9
ILD	Present	2	3
	Absent	64	97
PTB Seq	Present	10	15.2
	Absent	56	84.8

Table 2: Patient characteristics in the study

		Frequency	Percentage
Smoking Status	Current Smoker	27	40.9
	Former smoker	18	27.3
	Never Smoker	21	31.8
Location of the mass	Lung	62	93.9
	Mediastinal	2	3
	Pleural	2	3
Size of the lesion	<4 cm	4	6.1
	4-5 cm	7	10.6
	5-7 cm	24	36.4
	>7 cm	31	47
Pleural Effusion	Present	13	19.7
	Absent	53	80.3
Chest wall invasion	Present	21	31.8
	Absent	45	68.2
The radiological appearance of the mass	Dense lesion	39	59.1
	Lytic lesion	2	3
	Mixed lesion	25	37.9
USG guided Bx yield	No	4	6.1
	Yes	62	93.9
Post Procedure complications	Hemoptysis	2	3
	Pneumothorax	3	4.5
	No complications	61	92
Final report	Infection/Inflamation	1	1.5
	Adenocarcinoma	26	39.4
	Squamous cell carcinoma	18	27.3
	Small cell carcinoma	5	7.6
	Large cell carcinoma	3	4.5
	Sarcomatoid carcinoma	3	4.5
	Metastasis	4	6.1
	Lymphoma	2	3
	Inconclusive	4	6.1

Table 3: Comparison of USG guided Bx yield with Final report accuracy using Receiver Operating

Area Under the Curve			
Area	**p-value**	**95% C.I**	
		LB	**UB**
0.867	0.014 *	0.611	1
* Significant at p < 0.05 level			
		95% C.I	
Sensitivity	98.4	95.1	99.9
Specificity	75	24.8	97.8
PPV	98.4	95.1	99.9
NPV	75	24.8	97.8
Accuracy	97	90.9	99.7

Table 4. USG guided Bx yield

USG guided Bx yield	**Final report**		**Total**
	Yes	**No**	
Yes	61	1	62
No	1	3	4
Total	62	4	66

Table 5: Comparison of size of the lesion between final report and post-procedural complications

Size of the lesion	**Final report**			**P-value**
	Yes	**No**		
<4 cm	4 (6.5%)	0%		> 0.05
4-5 cm	7 (11.3%)	0%		
5-7 cm	22 (35.5%)	2 (50%)		
>7 cm	29 (46.8%)	2 (50%)		
Size of the lesion	**Post Procedural Complications**			**P-value**
	Hemoptysis	**Pneumothorax**	**No complications**	

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<4 cm	0%	1 (33.3%)	2 (3.3%)	< 0.01
>7 cm	0%	0%	33 (54.1%)	
4-5 cm	2 (100%)	1 (33.3%)	4 (6.5%)	
5-7 cm	0%	1 (33.3%)	22 (36.1%)	

DISCUSSION

Our study reveals age distribution of < 20 years was 3%, 21-35 years was 6.1%, 36-50 years was 21.2%, 51-65 years was 42.4%, and >65 years was 27.3%. Hence, the predominant presentation in the age group between 51-65 years. Among 66 cases, patients less than 20 years of age had mediastinal lymphoma, and others had primary lung carcinoma or metastasis. In our study, gender involvement in females is 13.6%, the male is 86.4%, and predominant involvement is seen in the male population. Khan RA et al,[12] study reported the gender distribution - 84.1% were male and 15.9% were females, similar to our study.

In our study, most patients presented with complaints of cough at 78.8%, followed by loss of weight which is seen in 71.2%, chest pain at 51.5%, loss of appetite at 43.9%, shortness of breath seen in 68.2% (16.7% had grade 1, 25.8% had grade 2, 22.7% grade 3, 3% had grade 4 MMRC) haemoptysis present is 27.3%, 4.5% patients don't have any respiratory symptoms. Some presented with headaches, for which evaluation was done and found to have brain metastasis, and screening CT of the chest showed lung mass. Few patients presented with acute respiratory symptoms. Hence, COVID-19 infection was suspected, but chest CT showed a mass lesion in the lung.

The prior respiratory comorbidities were analysed, revealing that 3% had bronchial asthma, 12.1% had emphysematous lung disease (all had a history of chronic smoking), 3% had Interstitial lung disease, and 15.2% had a prior pulmonary tuberculosis treatment. Among them, most of the patients were concluded as radiologically diagnosed with pulmonary tuberculosis without microbiological confirmation. They were initially presented as small air space opacities in chest x-ray and started on an antituberculosis regimen based on suspicion of consolidation caused by Pulmonary tuberculosis by nearby health professionals. Later, during treatment completion, there was no clinical improvement with the ATT regimen, and they were referred to a higher centre (RGGGH) for further evaluation. By doing the CECT Chest, they found mass lesions in the lungs. And further workup is being done.

The size of the lesion in the CECT chest was analysed. <4 cm mass seen in 6.1% of patients, 4-5 cm seen in 16%, 5-7 cm seen in 36.4%, and >7 cm seen in 47%. 19.7% of patients had malignant pleural effusion, and 31.8% had chest wall invasion by the mass. The Radiological Appearance of the mass in the CECT chest were categorised into dense, mixed, and lytic lesions. Most lesions were noted as dense lesions, seen in 59.1%, Mixed, where 37.9% had varying portions of dense and lytic lesions & 3% had only Lytic components without solid density radiologically.

Among 66 cases, 64 had lung mass lesions, and 2 had mediastinal mass lesions. All underwent preliminary USG assessment for site, size, vascularity, total length from skin to inner margin of the mass, total depth of the mass, length of parenchymal-pleural contact, area of internal necrosis, and accurate needle pathway. Out of 66 cases, a solid tissue sample was obtained for 62 cases. Of about 3-4 adequate viable tissues obtained & each tissue sample length was around 0.3-1 cm. For 2 cases, only necrotic tissue was obtained, so a repeat biopsy was done with CT guidance. In the remaining 2 cases, no tissue/ liquid was obtained. Those two patients were not willing for further evaluation and were discharged.

Among 66 cases, 61 didn't develop any complications following the procedure. 2 patients developed hemoptysis & 4.5% developed pneumothorax. They recovered with O2 supplementation alone without requiring an intercostal drainage tube. Sconfienza LM et al,[13] study had post-procedure complications of pneumothorax, observed in 5.8% of the study population, which is higher than ours. Among 62 positive outcomes, 26 had adenocarcinoma, 18 had squamous cell carcinoma, 5 had small cell carcinoma, 3 had large cell carcinoma, 3 had sarcomatoid carcinoma, 4 had pulmonary metastasis from extrapulmonary organ carcinoma, 2 had lymphoma, 1 had tuberculous granuloma.

But in Khan RA et al,[12] studies had adenocarcinoma -3.5%, Atypical cell- 1.8%, Bronchioloalveolar mucinous-type carcinoma-0.8%, Large-cell carcinoma-0.8%, Small-cell lung carcinoma -28.1%, Squamous cell carcinoma -63.2%, Undifferentiated (anaplastic) carcinoma -1.7% in our study which had predominant adenocarcinoma followed by squamous cell carcinoma.

CONCLUSION

The study concluded that a USG-guided lung biopsy can provide a high accuracy rate of 97%, similar to a CT-guided lung biopsy. This method offers good diagnostic yield with a sensitivity of 98.4%, specificity of 75%, PPV of 98.4%, and NPV of 75%. Mass lesions larger than 5 cm can be assessed using USG. However, the size of the mass and diagnostic yield are irrelevant, especially for large mass lesions with lytic components and variable density. Therefore, more than 5 cm mass lesions with a non-necrotic component can be selected for USG-guided biopsy without complications. Dense mass lesions yield good yields following USG-guided biopsy. In cases with only lytic components, surgical resection of the lung is necessary for histopathological examination. Complications following the procedure were minimal, with only 4.5% of patients developing mild pneumothorax, which can be managed with

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oxygen supplementation alone. The study successfully performed a guided biopsy for two patients with anterior mediastinal mass.

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