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Original Research Article

ROLE OF ULTRASOUND GUIDED FNAC IN DIAGNOSING LUNG PARENCHYMAL OPACITIES AT TERTIARY CARE HOSPITAL

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ABSTRACT

Background: Lung parenchymal opacities represent a significant challenge in pulmonary medicine, being indicative of a wide array of underlying conditions ranging from benign infections to life-threatening malignancies [1]. Among the diagnostic tools available, ultrasound-guided fine-needle aspiration cytology (FNAC) has emerged as a minimally invasive yet highly effective method for evaluating lung parenchymal opacities, particularly peripheral lesions [2]. The objective is to study the diagnostic utility and efficacy of USG-guided FNAC in lung parenchymal opacities.

Materials and Methods: This is a prospective observational study among 112 in-patients of Pulmonology Dept, GGH, Kakinada. Patients with suspected lung carcinoma, non-resolving pneumonia, non-vascular peripheral lung lesions within 8cm from skin surface on ultrasound and incidental lesions on radiograph are taken for the study. Diagnosed infections, recent myocardial infarction, vascular lesions, suspected hydatid cysts and deep lesions >8cm from skin surface on ultra-sound & severe PAH are excluded. Patients were subjected to USG-FNAC and data was summarized & analysis was done using SPSS software.

Results: Radiological distribution involved right lower (32.1%), left lower (24.1%) and right middle lobes (17.0%). USG-FNAC demonstrated a high adequacy rate of 94.6% whereas inadequate samples are 5.4%. Among these, malignancy 58.03% was common, followed by infective 36.6% and inconclusive 4.5%, while benign cases are at 0.9%. While 91.9% of procedures are uneventful, mild haemoptysis (3.6%) and pneumothorax (4.5%) are only complications.

Conclusion: USG-FNAC proved to be safe, minimally invasive and effective diagnostic tool for evaluating lung parenchymal opacities, especially peripheral lesions. It achieved a high diagnostic yield and accuracy 94.6%, with minimal complications.

Keywords: Fine-needle aspiration cytology, lung ultrasound, malignancy, Peripheral lung lesions, pulmonary infections.

INTRODUCTION

Lung parenchymal opacities represent a significant challenge in pulmonology, being indicative of a wide array of underlying conditions ranging from benign infections to life-threatening malignancies. Early and accurate diagnosis is essential, as underlying conditions often require different approaches, ranging from antibiotic therapy to surgical intervention or chemotherapy.[1] Among the diagnostic tools, ultrasound (USG)-guided fine-needle Aspiration cytology (FNAC) has emerged as a minimally invasive, highly effective method for evaluating lung parenchymal opacities in particularly peripheral lesions.[2] FNAC has become an indispensable tool allowing for precise sampling with

minimal patient discomfort.[3] USG-guided FNAC offers real-time visualization, differentiates between vascular and nonvascular lesions, ensures accurate needle placement and minimizes radiation exposure, making it a safer option for patients requiring repeated investigations while reducing risk of complications. It is advantageous in patients where procedures like bronchoscopy or surgical biopsy are contra-indicated.[4] Despite this, it remains underutilized & additionally, there is variability in diagnostic accuracy reported in literature, which may be influenced by factors such as operator experience, lesion characteristics, and patient selection criteria.[5]

The use of ultrasound in pulmonology dates back to 1980s when advancements in imaging technology began to visualize thoracic structures. Initially used for pleural and diaphragmatic evaluations, ultrasound has expanded to include visualizing lung parenchymal abnormalities. Today, it is recognized as an invaluable tool in evaluating peripheral lung lesions, pleural effusions, and mediastinal masses.[6]

According to the World Health Organization, lung cancer accounts for nearly 2.1 million new cases and 1.8 million deaths annually, making it the leading cause of cancer-related mortality worldwide. Similarly, TB remains a major public health challenge, with an estimated 10 million new cases and 1.6 million deaths reported each year.[7] In India, this burden is more due to high smoking prevalence, air pollution and dual epidemic of TB and HIV.[8]

[Figure 1] Types of parenchymal opacities.[9-14]

The FNAC technique, under USG or CT guidance is frequently used to diagnose safely all lung pathologies that are either non-resolving or slowly resolving, including hilar lesions.[15-17]

Banik T et al,[18] investigated increasing prevalence of lung carcinoma, particularly in females, emphasizing the importance of cytological alongside radiological investigations for early diagnosis, demonstrating that image-guided FNAC facilitates early detection and diagnosis of lung lesions, enabling appropriate management.

Similarly, Shailja Srivastava et al,[19] on 32 patients with peripheral lung lesions not invading chest wall, evaluated the efficacy of USG-guided FNAC, and concluded that it is a safe, cost-effective, quick, minimally invasive, and radiation free diagnostic method with high accuracy for peripheral lesions.

Present study aims to explore the diagnostic utility and efficacy of USG-guided FNAC in identifying and characterizing lung parenchymal opacities, contributing to timely and precise medical decision-making.

MATERIALS AND METHODS

This is a prospective observational study among 112 in-patients of Pulmonology Department, Government General Hospital, Kakinada over 18 months. Patients with radiologically identified lung parenchymal opacities, requiring further diagnostic evaluation were considered.

Patients with suspected lung carcinoma, non-resolving pneumonia, non-vascular peripheral lung lesions within 8cm from skin surface on ultrasound and incidental lesions on chest radiograph were included for the study.

Diagnosed infections like active tuberculosis and HIV, recent myocardial infarction, vascular lesions, suspected hydatid cysts and deep lesions >8cm from skin surface on ultra-sound & severe PAH patients are excluded.

Informed consent was obtained and patients were subjected to USG-FNAC and standard operating procedure was followed according to the British Thoracic Society guidelines. Data was summarized using means, medians, standard deviations and percentages, and Chi-square test was used to assess associations between categorical variables, while t-tests or ANOVA were applied for comparing continuous variables across different groups. A p-value of < 0.05 was considered statistically significant and data analysis was done using SPSS software.

RESULTS

Mean age was 52.36 years with a standard deviation (SD) of 14.69 years. The majority were in 51-60 years (22.9%) and 61-70 years (32.1%) age groups and with 18-20 years making up only 1.8%. and there was male predominance, with 71 males (63.4%) and 41 females (36.6%).

CT Patterns: CT involved predominant right lower lobe in 36 patients (32.1%), followed by left lower lobe 27 (24.1%), right middle lobe in 19 patients (17.0%), left upper lobe in 9 (8.0%), and right upper lobe in 5 patients (4.5%) and multi-lobar involvement in 16 (14.3%) respectively.

Yield obtained: A high adequacy rate of 94.6%, with small proportion of inadequate samples (5.4%) was obtained. And out of 112, malignancies were most common (58.03%), followed by infective (36.6%) and inconclusive accounted for 4.5%, while benign lesions were 0.9%.

[Figure 2] Yield of USG-guided FNAC.

Among malignancy, adeno being most-common (26.4%), was followed by non-small cell (13.6%) and squamous cell carcinoma (11.8%). Others included small cell carcinoma (3.6%), mesothelioma (1.8%), poorly differentiated carcinoma (0.9%), and rare case of Ewing's sarcoma (0.9%). Infective and inflammatory conditions were 23.8%, with 21.4% showing inflammation, 4.5% lung abscess, 3.6% bacterial, 2.7% fungal infections, and 2.7% caseating tubercular inflammation. Rare findings included adipocyte cells (0.9%), effusion with collapse (1.8%), and inconclusive results in 4.5%. The presence of adipocyte cells only in one case can be attributed to inadvertent sampling of subpleural fat. Peripheral lesions often adjacent to pleural surfaces, can

occasionally yield fat cells, especially in case of benign process like a rounded atelectasis or a lipoma. Complications: Mild haemoptysis (3.6%) and pneumothorax (4.5%) were only reported complications, while 91.9% of procedures were uneventful.

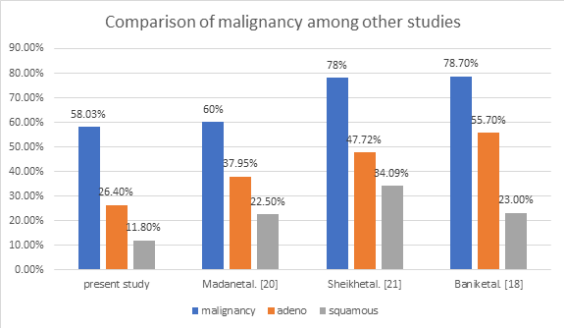
1. Types of parenchymal opacities

Category	Type	Description	Examples
Radiological Appearance	Alveolar (Airspace)	Filling of alveoli with fluid, pus, blood, or cells.	Pneumonia, Pulmonary edema, Pulmonary hemorrhage, Alveolar proteinosis
	Interstitial	Involvement of interstitial spaces, showing reticular, nodular, or reticulonodular patterns.	Idiopathic pulmonary fibrosis, Sarcoidosis, Lymphangitic carcinomatosis
	Nodular	Small, well-circumscribed round lesions classified as micronodules (<3 mm), nodules (3–30 mm), or masses (>30 mm).	Tuberculosis, Fungal infections, Primary or metastatic lung cancer
	Ground-Glass Opacities	Hazy areas of increased attenuation without obscuring underlying structures.	Early infections, Hypersensitivity pneumonitis, Alveolar hemorrhage, NSIP
	Consolidation	Homogeneous increase in opacity, obscuring vessels and airway walls.	Bacterial pneumonia, Aspiration pneumonia, Lung abscess
	Cavitary Opacities	Lung destruction forming cavities with/without air-fluid levels.	Tuberculosis, Lung abscess, Necrotizing pneumonia, Fungal infections
Distribution	Localized (Focal)	Affects specific segments or lobes.	Lung malignancy, Focal infections (e.g., pneumonia, abscess)
	Diffuse	Spread throughout both lungs.	Pulmonary edema, ARDS, Interstitial lung diseases
	Peripheral	Predominantly near outer lung fields.	Organizing pneumonia, Eosinophilic pneumonia, Chronic pulmonary embolism
	Central	Predominantly in perihilar regions.	Pulmonary edema, Pneumocystis jirovecii pneumonia, Sarcoidosis
Etiology	Infectious Causes	Infections of bacterial, viral, or fungal origin.	Bacterial pneumonia (e.g., S. pneumoniae), Viral pneumonia, Tuberculosis, Aspergillosis
	Malignant Causes	Neoplastic processes, primary or metastatic.	Adenocarcinoma, Squamous cell carcinoma, Lymphoma
	Inflammatory Causes	Immune-mediated conditions.	Sarcoidosis, Hypersensitivity pneumonitis, Rheumatoid arthritis-associated lung disease
	Vascular Causes	Related to blood vessels or hemorrhage.	Pulmonary embolism with infarction, Pulmonary hemorrhage, Granulomatosis with polyangiitis
	Traumatic/Mechanical	Resulting from trauma or physical factors.	Pulmonary contusion, Atelectasis
	Other Causes	Miscellaneous etiologies including metabolic and occupational causes.	Pulmonary edema, Drug-induced lung injury, Alveolar proteinosis, Pneumoconiosis (e.g., silicosis)

2. Yield of USG-guided FNAC.

Cytological finding	Frequency	Percentage (%)
Malignant Conditions		
Adenocarcinoma	29	26.4%
Squamous Cell	13	11.8%
Small Cell Carcinoma	4	3.6%
Non-small cell carcinoma	15	13.6%
Mesothelioma	2	1.8%
Poorly Differentiated Carcinoma	1	0.9%
Ewing's Sarcoma	1	0.9%
Infective/Inflammatory Conditions		
All Inflammation	24	21.4%
Fungal	3	2.7%
Infective conditions	4	3.6%
Caseating Tubercular Inflammation	3	2.7%
Lung Abscess	5	4.5%
Other Diagnoses		
Adipocyte Cells Only	1	0.9%
Effusion with Collapse	2	1.8%
Inconclusive	5	4.5%

3. Comparison of cytological findings among various studies



DISCUSSION

In present study, majority were in 51–60 years (22.9%) and 61–70 years (32.1%) age groups, accounting for 66% as middle-aged and elderly. The mean age was 52.36 years, with a standard deviation (SD) of 14.69 years. A smaller proportion i.e., 1.8% belonged to younger age groups between 18–20 years. This is similar to studies by Madan et al,[20] Banik et al,[18] Sheikh et al,[21] Srivastava et al,[22] and Dahlstrom et al,[24] who reported a higher incidence in middle-aged and elderly, typically beyond fourth decade. This is attributable to cumulative environmental exposures, occupational risks, smoking histories and age-related physiological changes in lung parenchyma. These findings highlight the importance of clinical vigilance for lung pathologies in elderly, given their increased susceptibility.

Gender: In present study, male predominance was observed where, of 112 patients, 71 (63.4%) were male, and 41 (36.6%) were female, with male-to-female (M: F) ratio of 3:1.

Our study's M:F ratio of 3:1 is slightly higher than those reported by Srivastava et al,[22] (1.6:1), Sheikh et al,[21] (63.93%males), and Banik et al,[18] (69.2%males). It is closely aligned with Madan et al,[21] where the ratio was even more pronounced among malignancy-proven cases, with a ratio of 5:1. This higher male preponderance can be attributed to smoking among males as most significant risk factor. Additionally, exposure to environmental pollutants, such as industrial chemicals, asbestos, and other carcinogens, are more prevalent in male-dominated professions like mining, construction, heavy industries. These contribute to increased susceptibility of men to both benign and malignant lung diseases. The 3:1 in our study highlights the higher frequency of lung diseases in males, emphasizing the critical need for targeted public health interventions to aim at reducing smoking and environmental exposures, particularly among male populations.

CT Distribution: CT involved predominant right lower lobe in 36 patients (32.1%), followed by left lower lobe 27 (24.1%), right middle lobe in 19 patients (17.0%), left upper lobe in 9 (8.0%), and right upper lobe in 5 patients (4.5%) and multi-lobar involvement in 16 (14.3%) respectively. This suggests a predilection for lower lobes and it correlates well with known clinical behaviour of various pulmonary pathologies, like infections, like tuberculosis, with an upper lobe predilection, and malignancies showing lower lobes tendency.

Further, multiple studies like Banik et al,[18] Madan et al,[20] Sheikh et al,[21] Srivastava et al,[22] Dahlstrom et al,[23] Gouliamos et al,[24] Li et al., and Garpestad et al,[25] consistently demonstrated the use of CT for localization and guidance of percutaneous or transbronchial needle aspirations, but specific lobe-wise distribution data remained underreported. However, they support essential role of CT in lesion characterization. The significant lower lobe involvement, frequent multi-lobar disease, and relatively low upper lobe involvement in this study correspond well with known radiologic and pathological behaviours of diseases, reinforcing the need of CT-based lobar distribution analysis in disease evaluation.

YIELD OF USG-FNAC: USG-FNAC yielded adequate material in 106 cases (94.6%), while 6 (5.4%) were deemed inadequate. This high adequacy rate reflects the effectiveness of USG -guided FNAC in evaluating thoracic lesions. When compared, this closely aligns with studies like that of Madan et al,[20] and Banik et al,[18] which reported around 90% adequacy of sample. The accuracy rates were low in studies done by Chandrasekhar et al,[26] 75%, 87% by Afschrift et al,[27] and Srivastava et al,[22] 81%. These variations reflect differences in methodology, imaging modalities, and case mix. Present study, with its higher adequacy rate, falls within upper range of these reported values, underscores the reliability of USG-guided FNAC as a diagnostic tool.

Etiology of Opacities: Out of 112, 65 patients (58.03%) had malignancy, 41 were (36.6%) infective, 1 (0.9%) was benign, and 5 (4.5%) were inconclusive. This distribution emphasizes malignancy as leading etiology, followed by infections, which is consistent with various studies. The present study's malignancy rate of 58.03% is very much in line with previous research. Madan et al,[20] observed malignancy in 24 out of 40 cases (60%), almost identical to our findings. Sheikh et al,[21] reported a higher incidence, with 78% of their patients having malignancy. The lower malignancy percentage in our study could be attributed to a variety of factors, like differences in demographics & sample characteristics (e.g., types of lesions).

[Figure 3] comparison of cytological findings among various studies

It is well-established that adenocarcinoma typically presents as peripheral lung mass, a trend that is corroborated by our study as 26.4% and is in-line with findings from Banik et al.[18]

Squamous cell carcinoma was identified in 13 (11.8%), which remains in close agreement with Banik et al,[18] (23.0%) and Madan et al,[20] (22.5%). This decrease might be due to its central tendency, as opposed to adeno's peripheral predilection.

Small cell carcinoma was seen in 4 (3.6%), which is consistent with its known central location and rarity in peripheral lesions. This is lower than figures from Madan et al,[20] (7.5%) and Banik et al,[18] (13.5%). Our cohort's focus on peripheral lesions likely accounts for this reduced representation of small cell carcinoma.

Mesothelioma was seen in 2 (1.8%), highlighting the rarity of this pleural-origin malignancy. This contributes to the growing recognition of mesothelioma's potential to masquerade as peripheral lesions when it involves lung.

Poorly differentiated carcinoma, which presents with small cell phenotype, was observed in 1 (0.9%), similar to Madan et al.[20] Srivastava et al,[22] found 9% as poorly differentiated, which is higher than our observation. This discrepancy could be related to differences in location, as peripheral lesions are less likely to exhibit poor differentiation compared to central or larger lesions. Ewing's sarcoma was observed in 1 (0.9%), which is extremely rare. It is a small round blue cell tumor primarily affecting bones and soft tissue but can occasionally present as lung mass. Dahlstrom et al,[23] also reported Askin tumor, related to Ewing's sarcoma. Presence of this rare malignancy underscores the importance of considering unusual neoplasms when evaluating solitary peripheral opacities, particularly in youngsters.

Infective and Inflammatory Conditions: In our study, inflammatory conditions accounted for 24 (21.43%), which closely aligns with Madan et al,[20] who found 20% to be inflammatory. Fungal infections were observed in 3 (2.7%), which is consistent with literature where these, can present as peripheral lesions.

Caseating tubercular inflammation was noted in 3 (2.7%). This is lower than Srivastava et al,[22] finding of 13.5% of tubercular lesions. Tuberculosis can present as a peripheral opacity, often creating a diagnostic challenge due to overlapping features with malignancy. Despite its relatively low percentage of 2.7%, it remains crucial to consider tuberculosis in differential diagnosis of peripheral lung lesions, particularly in endemic areas. Lung abscess was identified in 5 (4.5%), which supports the importance to distinguish it from malignancies.

Other Diagnoses: Adipocyte cells were observed in 1 (0.9%), reflecting the issue when peripheral lesions in proximity to sub pleural fat are being aspirated, can lead to sampling of fat cells rather than lung parenchyma, and is a well-known limitation of FNAC for peripheral lung lesions.

Inconclusive results were noted in 5 (4.5%), similar to 5% reported by Madan et al.[20] They are a common challenge in FNAC and necessitate the importance of combining cytology with imaging and clinical evaluation, followed by biopsy.

COMPLICATIONS:

Pneumothorax was seen in 5 (4.5%) in our study. Sheikh et al,[21] reported only 2 patients with pneumothorax, and Srivastava et al,[22] reported 3.1% in their studies. All were managed successfully with high flow oxygen therapy, eliminating interventional need of intercostal tube placement.

Mild haemoptysis is seen in 4 (3.6%), which is slightly higher than Sheikh et al,[21] study which reported only one out of 61, which may be attributed to less vascular cohort, smaller sample size, influencing lower incidence. Haemoptysis following FNAC can occur due to needle trauma or irritation of small blood vessels in lung parenchyma, particularly in highly vascular tumours. However, this is generally mild and transient complication in most and often self-resolving.

Majority in our study, 103 (91.9%), experienced no complications. This aligns closely with other studies, including Sheikh et al,[21] and Dahlstrom et al,[23] who observed a significant proportion without any major complications. Sheikh et al,[21] mentioned complications like mild pneumothorax and hemoptysis, which underscores the relative safety of USG-guided FNAC when performed appropriately.

Our study didn't report any other major complications like air-embolism, hemorrhage or mortality, which aligns with findings of Sheikh et al,[21] and Dahlstrom et al.[23]

CONCLUSION

Our study demonstrates that ultrasound-guided FNAC is highly effective and reliable diagnostic tool for evaluating lung parenchymal opacities. It highlights the predominance of malignancy, particularly adenocarcinoma, and infective conditions, including tuberculosis and lung abscesses among patients with lung parenchymal opacities. It further emphasizes the importance of differentiating between malignant and infective processes, as their clinical and radiological presentations can overlap. With the majority of cases being in middle-aged and elderly, the study underscores the growing concern of lung malignancies in these populations. FNAC, combined with clinical and radiological assessments, provides diagnostic clarity, especially where imaging alone is inconclusive. With low incidence of complications and high safety profile, ultrasound-guided FNAC is a valuable, minimally invasive & non-radiation procedure that aids in accurate diagnosis, guiding effective management of lung parenchymal opacities.

Limitations: The study involved a relatively small sample size of 112 patients, which may limit the generalizability of findings to larger or more diverse populations. Being a single-center study, the results may not fully represent regional or demographic variations in the patterns and etiologies. A small proportion yielded inconclusive results on FNAC, though uncommon, it highlights potential limitations in sampling accuracy and cytological interpretation.

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