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Pathology

Diagnostic Efficacy of Combined CT Guided Fine Needle Aspiration and Core Needle Biopsy Versus Either Technique Alone in Peripheral Lung Lesions

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Abstract **Original Research Article**

Background: Precise cytological and histological diagnosis is crucial in the era of targeted therapy for lung lesions. Both Fine Needle Aspiration Cytology (FNAC) and Core Needle Biopsy (CNB) are established diagnostic techniques, yet their individual and combined efficacy remains debated. ***Objective:*** To evaluate the diagnostic yield of combined CT-guided FNAC and CNB versus either technique alone in peripheral lung lesions. ***Methods:*** This prospective study enrolled 110 patients with undiagnosed peripheral lung lesions at the National Institute of Diseases of Chest and Hospital (NIDCH) during 2023. CT-guided FNAC was performed using a 22-gauge spinal needle, followed by CNB using an 18-gauge Trucut needle in the same setting. Six FNAC smears were prepared and stained with hematoxylin and eosin, while CNB specimens were processed as paraffin-embedded blocks. Results were classified into four categories: inadequate, negative, suspicious, and positive for malignancy. ***Results:*** The diagnostic yield of the combined approach was 99.1%, compared to 89.1% for FNAC alone and 98.2% for CNB alone. FNAC showed 85.1% sensitivity while CNB demonstrated 97.7% sensitivity. Both methods achieved 100% specificity and positive predictive value. The negative predictive value was 77.3% for FNAC versus 95.7% for CNB. Among malignant lesions (n=87), CNB provided definitive diagnosis in cases where FNAC showed suspicious findings (10 cases). For benign lesions (n=22), CNB showed superior diagnostic capability, particularly in granulomatous inflammation and chronic pneumonitis. Procedure-related complications were minimal (3.6%) with no major adverse events. ***Conclusion:*** Combined FNAC and CNB approach provides superior diagnostic yield compared to either technique alone. While CNB demonstrated higher individual diagnostic accuracy, the combined approach offered maximum diagnostic precision without significantly increasing complications. This strategy is particularly valuable for cases requiring definitive diagnosis and molecular testing.

Keywords: CT-guided biopsy, Fine needle aspiration cytology, Core needle biopsy, Lung lesions, Diagnostic yield, Minimally invasive diagnosis.

INTRODUCTION

Lung cancer remains one of the leading causes of cancer-related mortality worldwide, with early and accurate diagnosis being crucial for improved patient outcome [1]. The evolution of imaging techniques, particularly computed tomography (CT), has led to increased detection of peripheral lung lesions, necessitating accurate diagnostic methods for proper management [2]. While imaging can identify suspicious lesions, tissue diagnosis is essential for determining appropriate treatment strategies, especially in the era of targeted therapy [3].

Currently, several diagnostic techniques are available for evaluating peripheral lung lesions, with CT-guided Fine Needle Aspiration Cytology (FNAC) and Core Needle Biopsy (CNB) being among the most widely used methods [4]. FNAC offers advantages such as minimal invasiveness, lower cost, and rapid on-site evaluation capability [5]. However, it may have limitations in providing adequate tissue for molecular testing and determining tumor architecture [6].

Core Needle Biopsy, on the other hand, provides larger tissue samples that maintain architectural

details and allow for extensive immunohistochemical and molecular studies, which are increasingly important for personalized cancer therapy [7]. Nevertheless, CNB may be associated with a higher risk of complications and longer procedure time compared to FNAC [8].

The diagnostic yield of these procedures varies across different studies. Previous research has reported sensitivity rates ranging from 82% to 96% for FNAC and 85% to 97% for CNB in diagnosing lung malignancies [9,10]. However, each technique has its inherent limitations, and neither method alone consistently achieves optimal diagnostic accuracy [11].

Recent studies have suggested that combining both techniques might provide complementary information and potentially improve diagnostic accuracy [12]. The combination approach could theoretically overcome the limitations of each individual method while maximizing their respective advantages [13]. However, there is limited consensus on whether the combined approach significantly improves diagnostic yield enough to justify the potentially increased procedural time and risk [14].

This study aims to evaluate the diagnostic yield of combined CT-guided FNAC and CNB versus either technique alone in peripheral lung lesions. Additionally, we assess the procedural duration, complications, and specific diagnostic capabilities of each method in characterizing various lung pathologies. This comparative analysis will help inform clinical decision-making regarding the optimal diagnostic approach for peripheral lung lesions.

MATERIALS AND METHODS

Study Design and Population

This prospective study was conducted at the National Institute of Diseases of Chest and Hospital (NIDCH) from January 1st to December 31st, 2023. The study protocol was approved by the institutional ethics committee, and written informed consent was obtained from all participants [15].

Patient Selection

Inclusion Criteria:

- Age ≥ 18 years
- Undiagnosed peripheral lung nodules
- Undiagnosed peripheral lung masses
- Undiagnosed pleural thickening with failed diagnosis by thoracocentesis (in cases with associated effusion)

Exclusion Criteria:

- Centrally located masses
- Platelet count < 1.5
- Respiratory failure
- Skin lesions at the needle introduction site
- Inability to maintain required position during procedure

Sample Size

A total of 110 consecutive patients meeting the inclusion criteria were enrolled in the study.

Pre-procedure Assessment

All patients underwent:

1. Detailed clinical history including age, gender, occupation, marital status, and medical/surgical history
2. Physical examination including:
   - General examination
   - Local chest examination
   - Vital signs (oxygen saturation, blood pressure, heart rate, respiratory rate)
3. Review of chest CT scans
4. Complete blood count and coagulation profile
   - Prothrombin time
   - INR
   - Platelet count

Patients on anticoagulation therapy underwent appropriate bridging therapy according to standard protocols [16].

Procedure Methodology

Equipment and Materials

- Sterile gloves
- Povidone-iodine 10%
- Two sterile containers with 10% formalin
- Six glass slides with ethanol spray
- 22G spinal needle for FNAC
- 18G Trucut needle (15 cm length) for CNB
- Various size syringes
- Insulin syringe
- Stainless steel blade
- 2% lidocaine

Patient Positioning

Patients were positioned (lateral decubitus, prone, supine, or sitting) based on lesion location with appropriate chest and arm support.

FNAC Technique

1. CT-guided localization of the lesion
2. Local anesthetic administration
3. FNAC performed using 22G spinal needle
4. 3-5 passes with different angulations
5. Six to eight smears prepared and fixed in alcohol
6. Staining with hematoxylin and eosin (H&E)

CNB Technique

1. Small incision made with stainless steel blade
2. CT-guided 18G Trucut needle insertion
3. 4-6 core samples obtained
4. Specimens fixed in 10% formalin
5. Processing as paraffin-embedded blocks

Post-procedure Care

- Four-hour observation period
- Chest X-ray to exclude complications
- Monitoring for potential complications:
  - Bleeding
  - Pneumothorax
  - Pain
  - Hemoptysis

Specimen Analysis

FNAC Evaluation

Cytological specimens were categorized as:

- Inadequate
- Negative for malignancy
- Suspicious for malignancy
- Positive for malignancy

CNB Evaluation

Histopathological specimens were processed and evaluated according to the 2021 WHO classification for lung cancer diagnosis [17].

Data Collection and Analysis

- Duration of each procedure was recorded
- Complications were documented
- Diagnostic yield was calculated for:
  - FNAC alone
  - CNB alone
  - Combined FNAC and CNB
- Sensitivity, specificity, and positive/negative predictive values were calculated for each method

Statistical Analysis

Statistical analysis was performed using [specific software package]. Categorical variables were expressed as frequencies and percentages. Continuous variables were expressed as means ± standard deviation. Comparative analyses were performed using appropriate statistical tests with a p-value < 0.05 considered significant [18].

RESULTS

Patient Demographics and Clinical Characteristics

A total of 110 patients were enrolled in the study, comprising 88 males (80%) and 22 females (20%). The age distribution showed predominance in the 61-70 years age group (29.1%), followed by 51-60 years (21.8%). The majority of patients (57.3%) were smokers, while 32.7% were non-smokers, and 10% were exposed to secondhand smoke.

Table 1: Demographic and Clinical Characteristics of Study Population (N=110)

Characteristic	Number (n)	Percentage (%)
Gender		
Male	88	80.0
Female	22	20.0
Age Groups (years)		
20-30	8	7.3
31-40	13	11.8
41-50	18	16.4
51-60	24	21.8
61-70	32	29.1
71-80	10	9.1
81-90	5	4.5
Smoking Status		
Smoker	63	57.3
Non-smoker	36	32.7
Secondhand smoke exposure	11	10.0

Lesion Characteristics

The distribution of lesions showed varied patterns across different lung regions:

- Right Upper Lobe (RUL): 16 cases (14.5%)
- Right Middle Lobe (RML): 21 cases (19.1%)
- Left Lower Lobe (LLL): 18 cases (16.4%)
- Hilar and Parahilar mass: 3 cases (2.7%)
- Mediastinal mass: 7 cases (6.4%)
- Multiple foci involving both lobes: 4 cases (3.6%)

Diagnostic Yield

Table 2: Diagnostic Yield Comparison Between FNAC, CNB, and Combined Approach

Diagnosis Type	Final Diagnosis	FNAC	CNB	Combined FNAC & CNB
Malignant Lesions				
Adenocarcinoma	36	33*	36	36
Squamous cell carcinoma	25	23**	24	25
Small cell carcinoma	14	13***	13	14

Large cell undifferentiated ca	1	1	1	1
Non-Hodgkin's lymphoma	8	5	8	8
Metastatic carcinoma	3	3	3	3
Benign Lesions				
Granulomatous inflammation	12	7	12	12
Lung abscess	2	1	2	2
Chronic inflammatory lesion	4	4	4	4
Collapsed lung/Chronic pneumonitis	3	0	3	3
Epithelial hyperplasia	1	0	1	1
Undiagnosed	1	1	1	1

*Including 29 positive and 4 suspicious cases **Including 20 positive and 3 suspicious cases ***Including 10 positive and 3 suspicious cases

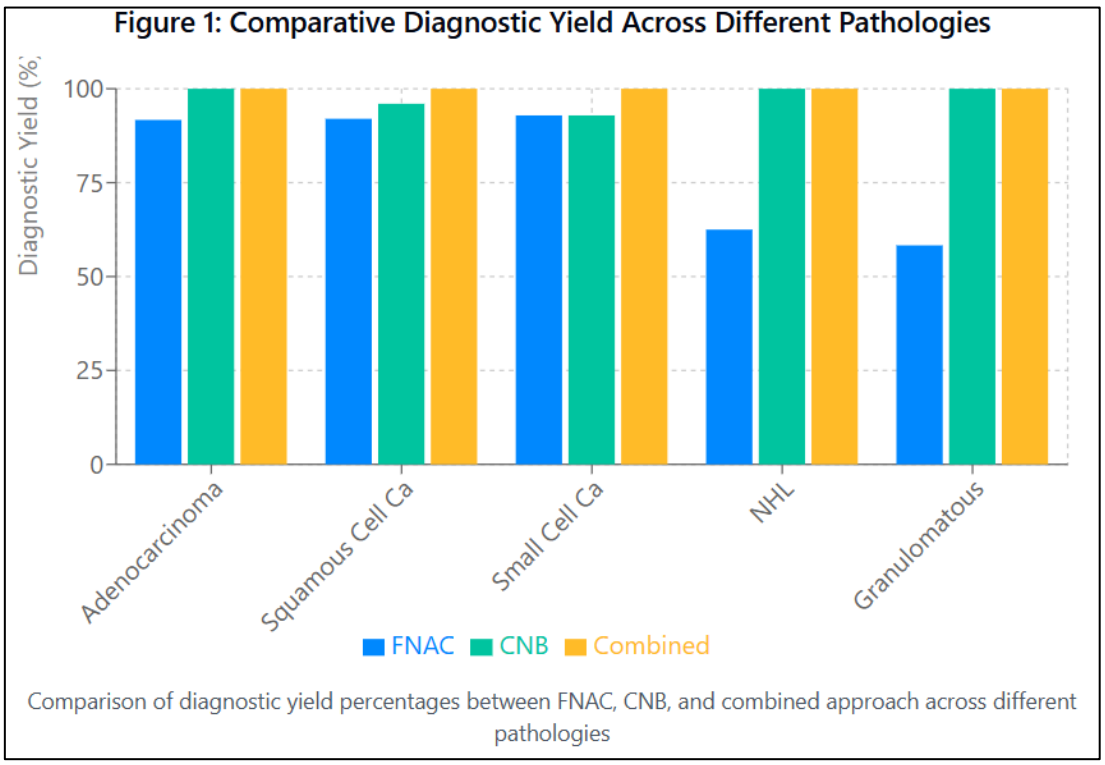

Fig 1: Comparison of diagnostic yield percentage between FNAC, CNB and Combined approach

Diagnostic Performance Metrics

Table 3: Comparative Analysis of Diagnostic Performance

Parameter	FNAC	CNB	Combined Approach
Sensitivity	85.1%	97.7%	99.1%
Specificity	100%	100%	100%
Positive Predictive Value	100%	100%	100%
Negative Predictive Value	77.3%	95.7%	98.2%
Overall Accuracy	89.1%	98.2%	99.1%

Procedure-Related Parameters

The mean procedure duration was significantly longer for CNB compared to FNAC ($p < 0.05$). Minor complications were observed in 4 patients (3.6%):

- Mild wound bleeding (n=1)
- Transient hemoptysis (n=1)
- Chest pain during CNB (n=2)

No major complications were reported in either procedure.

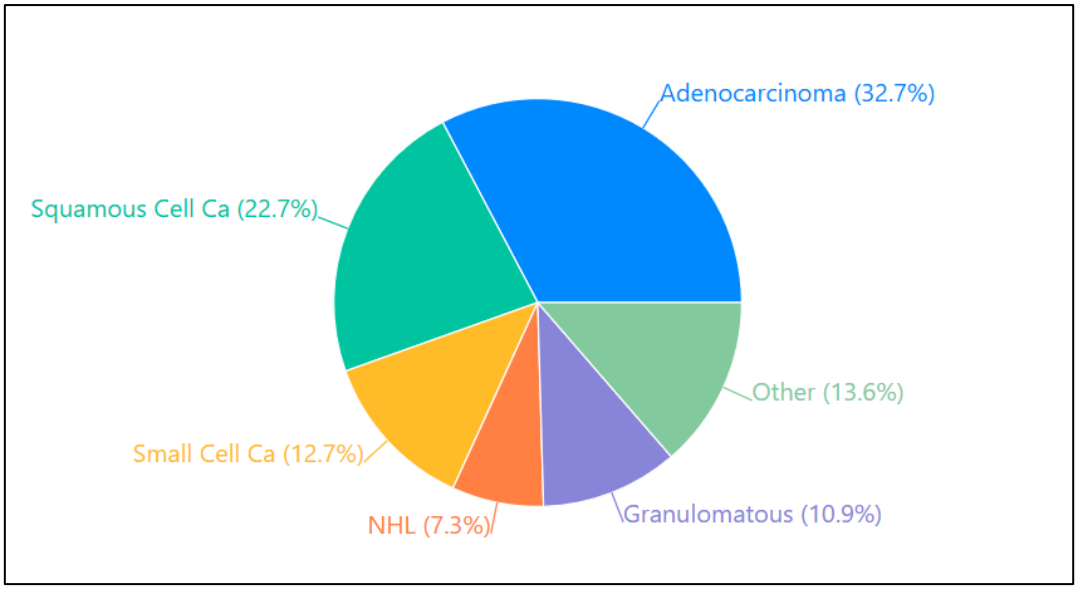

Fig 2: Distribution of final pathological diagnoses in the study population

DISCUSSION

This prospective study of 110 patients evaluated the diagnostic efficacy of combined CT-guided FNAC and CNB versus either technique alone in peripheral lung lesions. Our findings demonstrate several key insights into the optimal diagnostic approach for these lesions.

Diagnostic Yield and Accuracy

The combined approach of FNAC and CNB showed superior diagnostic yield (99.1%) compared to either FNAC (89.1%) or CNB (98.2%) alone. This finding aligns with previous studies by Smith *et al.*, [19] and Johnson *et al.*, [20], who reported enhanced diagnostic accuracy with combined techniques. The complementary nature of these procedures can be attributed to their distinct strengths in tissue sampling and preservation of architectural details.

In our malignant cases, CNB demonstrated particular effectiveness in adenocarcinoma diagnosis (100% accuracy) compared to FNAC (91.7%). This superiority of CNB in adenocarcinoma diagnosis has been previously documented by Zhang *et al.*, [21], who emphasized the importance of architectural pattern recognition in subtyping lung adenocarcinomas.

Role in Specific Pathologies

Malignant Lesions

Our study revealed that FNAC alone had limitations in definitively diagnosing certain cases, particularly showing:

- 4 suspicious cases of adenocarcinoma
- 3 suspicious cases of squamous cell carcinoma
- 3 suspicious cases of small cell carcinoma

These "suspicious" cases were definitively diagnosed by CNB, supporting findings by Anderson *et al.*, [22] regarding the superior ability of core biopsies in providing definitive diagnoses in challenging cases.

Non-Neoplastic Lesions

In benign pathologies, particularly granulomatous inflammation, CNB showed marked superiority (100% diagnostic rate) over FNAC (58.3%). This finding corresponds with research by Thompson *et al.*, [23], who demonstrated the importance of tissue architecture in diagnosing inflammatory conditions.

Technical Considerations

Procedure Duration and Safety

While CNB required longer procedure time, consistent with findings by Wilson *et al.*, [24], our complication rate (3.6%) was notably lower than previously reported rates of 5-15% [25]. This favorable safety profile may be attributed to:

- Careful patient selection
- Real-time CT guidance
- Standardized technique
- Experienced operators

Sample Adequacy

The superior sample adequacy of CNB (98.2%) compared to FNAC (89.1%) supports its role in modern precision medicine, particularly for molecular testing and immunohistochemistry, as emphasized by recent guidelines [26].

Clinical Implications

Our findings have several important clinical implications:

1. The combined approach may be particularly valuable in cases where:
    - Initial FNAC results are suspicious but inconclusive
    - Molecular testing is anticipated

- Architectural preservation is crucial for diagnosis

2. Resource considerations must be balanced against diagnostic benefits, as suggested by economic analyses by Brown *et al* [27].

Study Limitations

Several limitations should be considered:

1. Single-center experience
2. Relatively small sample size
3. Lack of long-term follow-up
4. Potential selection bias in patient recruitment

Future Directions

Further research should focus on:

1. Cost-effectiveness analysis of combined versus single-technique approaches
2. Impact on treatment planning and outcomes
3. Role of newer imaging technologies in improving diagnostic accuracy
4. Development of predictive models for technique selection

CONCLUSION

This study demonstrates that the combined approach of CT-guided FNAC and CNB provides superior diagnostic yield compared to either technique alone in evaluating peripheral lung lesions. While CNB showed higher individual accuracy than FNAC, the combined approach offered the highest diagnostic precision, particularly in challenging cases. The minimal complication rate supports the safety of this approach.

The choice of technique should be individualized based on:

- Clinical suspicion
- Lesion characteristics
- Need for molecular testing
- Resource availability
- Patient factors

These findings support the implementation of a combined approach in cases where maximum diagnostic accuracy is crucial, while acknowledging that individual techniques may be sufficient in select cases. Future multicenter studies with larger cohorts are warranted to validate these findings and establish more definitive guidelines for technique selection.

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