Section: Pathology

Original Research Article

A COMPARATIVE ANALYSIS OF FINE NEEDLE ASPIRATION CYTOLOGY (FNAC) VS. CORE NEEDLE BIOPSY IN THYROID LESIONS

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ABSTRACT

Background: Thyroid nodules are common clinical findings, and accurate differentiation between benign and malignant lesions is essential for appropriate management. Fine Needle Aspiration Cytology (FNAC) is widely used as the first-line diagnostic tool; however, it has limitations, particularly in indeterminate and non-diagnostic cases. Core Needle Biopsy (CNB) has emerged as an alternative modality providing better tissue architecture and potentially higher diagnostic accuracy. The aim is to compare the diagnostic accuracy of FNAC and Core Needle Biopsy in thyroid lesions. **Materials and Methods:** This prospective comparative observational study was conducted on 100 patients presenting with thyroid nodules at a tertiary care hospital over a period of 18 months. All patients underwent both FNAC and Core Needle Biopsy. Samples were processed using standard cytological and histopathological techniques. Diagnostic adequacy, yield, sensitivity, specificity, and overall accuracy were assessed. Statistical analysis was performed using chi-square test and t-test, with a p-value <0.05 considered significant. **Result:** Core Needle Biopsy demonstrated significantly higher diagnostic accuracy (95.0%) compared to FNAC (86.0%) (p=0.030). Adequate sampling was achieved in 96.0% cases with CNB versus 87.0% with FNAC (p=0.022). CNB showed higher sensitivity (91.9% vs 78.4%, p=0.034) and reduced indeterminate results (6.0% vs 17.0%, p=0.016). The need for repeat procedures was also significantly lower with CNB (p=0.003). **Conclusion:** Core Needle Biopsy is a more accurate and reliable diagnostic modality compared to FNAC for thyroid lesions, particularly in indeterminate cases. FNAC remains a useful.

INTRODUCTION

Thyroid nodules are among the most common endocrine abnormalities encountered in clinical practice, with a prevalence of 4-7% in the adult population on palpation and up to 60-70% on ultrasonography. The majority of these nodules are benign; however, a small but significant proportion may harbor malignancy, necessitating accurate and early diagnosis. Differentiating benign from malignant thyroid lesions is crucial for appropriate management, avoiding unnecessary surgeries in benign cases while ensuring timely intervention for malignant conditions.

Fine Needle Aspiration Cytology (FNAC) has long been established as the first-line diagnostic modality for the evaluation of thyroid nodules due to its simplicity, cost-effectiveness, minimal invasiveness, and high sensitivity and specificity. FNAC plays a pivotal role in stratifying thyroid nodules using reporting systems such as the Bethesda System for Reporting Thyroid Cytopathology, which categorizes lesions into benign, malignant, and indeterminate groups. Despite its widespread use, FNAC has certain limitations, particularly in cases of follicular-patterned lesions, where it cannot reliably distinguish between follicular adenoma and carcinoma due to the inability to assess capsular or vascular invasion. Additionally, non-diagnostic or inadequate samples may occur, reducing its diagnostic utility.[1]

Core Needle Biopsy (CNB) has emerged as an adjunct or alternative diagnostic tool in the evaluation of thyroid lesions, especially in cases where FNAC results are inconclusive or indeterminate. CNB provides a larger tissue sample with preserved histological architecture, allowing better evaluation

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of tissue architecture, stromal components, and capsular invasion. This makes CNB particularly useful in diagnosing follicular neoplasms, lymphoma, and other lesions where cytology alone may be insufficient. However, CNB is relatively more invasive compared to FNAC and requires greater technical expertise, imaging guidance, and carries a slightly higher risk of complications such as bleeding or hematoma formation.[2]

With advancements in imaging techniques, especially high-resolution ultrasonography, both FNAC and CNB are increasingly performed under image guidance, improving diagnostic yield and accuracy. The choice between FNAC and CNB remains a subject of ongoing debate, particularly in terms of diagnostic accuracy, sensitivity, specificity, patient comfort, and cost-effectiveness. Comparative evaluation of these modalities is essential to establish evidence-based guidelines for the optimal diagnostic approach to thyroid nodules.[3]

Aim: To compare the diagnostic accuracy of Fine Needle Aspiration Cytology and Core Needle Biopsy in thyroid lesions.

Objectives

1. To evaluate and compare the adequacy and diagnostic yield of FNAC and Core Needle Biopsy in thyroid nodules.
2. To assess the sensitivity, specificity, and overall diagnostic accuracy of both modalities in detecting benign and malignant thyroid lesions.

MATERIALS AND METHODS

Source of Data: The data for the present study were obtained from patients presenting with thyroid swellings in the outpatient and inpatient departments of the selected tertiary care hospital. All eligible patients who underwent both FNAC and Core Needle Biopsy for thyroid lesions during the study period were included. Relevant clinical details, imaging findings, and histopathological reports were collected from hospital records and patient case files.

Study Design: The study was conducted as a prospective comparative observational study, aimed at evaluating and comparing the diagnostic performance of FNAC and Core Needle Biopsy in thyroid lesions.

Study Location: The study was carried out in the Department of Pathology in collaboration with the Departments of Surgery and Radiology at a tertiary care teaching hospital.

Study Duration: The study was conducted over a period of 12 months, including patient recruitment, sample collection, processing, and analysis.

Sample Size: A total of **100 patients** presenting with thyroid nodules and fulfilling the inclusion criteria were included in the study.

Inclusion Criteria

- Patients aged above 18 years presenting with clinically or radiologically detected thyroid nodules.
- Patients who underwent both FNAC and Core Needle Biopsy.
- Patients who provided informed consent for participation in the study.

Exclusion Criteria

- Patients with bleeding disorders or contraindications to biopsy procedures.
- Patients unwilling to participate or not providing consent.
- Patients with recurrent thyroid malignancy already diagnosed.
- Inadequate or improperly preserved samples.

Procedure and Methodology

All patients with thyroid nodules were initially evaluated clinically and subjected to ultrasonography of the neck. FNAC was performed under aseptic precautions using a 23-25-gauge needle, with or without ultrasound guidance. Multiple passes were made to obtain adequate cellular material. Smears were prepared on clean glass slides, air-dried and alcohol-fixed for staining.

Core Needle Biopsy was performed subsequently under ultrasound guidance using an automated biopsy gun with an 18-20-gauge core needle. Adequate tissue cores were obtained while ensuring patient safety and minimizing complications. All procedures were performed by experienced clinicians or radiologists.

Both FNAC and CNB findings were interpreted independently by pathologists who were blinded to each other's results to avoid bias.

Sample Processing: FNAC smears were stained using May-Grünwald-Giemsa (MGG) and Papanicolaou stains for cytological evaluation. CNB specimens were fixed in 10% formalin, processed routinely, embedded in paraffin, and stained with Hematoxylin and Eosin (H&E) for histopathological examination.

Where required, additional special stains or immunohistochemistry were performed to aid diagnosis.

Statistical Methods: Data were entered into Microsoft Excel and analyzed using appropriate statistical software. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated for both FNAC and CNB, considering histopathology as the gold standard where available.

Comparisons between the two modalities were performed using the Chi-square test or Fisher's exact test. A p-value of <0.05 was considered statistically significant.

Data Collection: Data were collected using a predesigned structured proforma including demographic details, clinical findings, imaging characteristics, FNAC results, CNB findings, and final histopathological diagnosis. All data were systematically recorded, verified, and analyzed to ensure accuracy and reliability of study outcomes.

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RESULTS

In the present study, Core Needle Biopsy demonstrated superior diagnostic performance compared to FNAC. A correct diagnosis was achieved in 95.0% of cases using Core Needle Biopsy as compared to 86.0% with FNAC, while incorrect diagnoses were lower in Core Needle Biopsy (5.0%) than FNAC (14.0%). This difference was statistically significant (χ^2 = 4.71, p = 0.030), with a 95% confidence interval ranging from 1.82 to 16.18, indicating a meaningful improvement in diagnostic accuracy with Core Needle Biopsy. Furthermore, the mean diagnostic accuracy score was significantly higher for Core Needle Biopsy (9.18 ± 0.91) compared to FNAC (8.42 ± 1.36), and this difference was highly statistically significant (t = 4.65, p < 0.001; 95% CI: 0.44-1.08).

Table 1: Diagnostic Accuracy of FNAC and Core Needle Biopsy in Thyroid Lesions

Parameter	FNAC n (%)	Core Needle Biopsy n (%)	Test value	95% CI	p-value
Correct diagnosis	86 (86.0%)	95 (95.0%)	χ^2 = 4.71	1.82-16.18	0.030
Incorrect diagnosis	14 (14.0%)	5 (5.0%)			
Mean diagnostic accuracy score	8.42 ± 1.36	9.18 ± 0.91	t = 4.65	0.44-1.08	<0.001

Table 2: Adequacy and Diagnostic Yield of FNAC and Core Needle Biopsy

Parameter	FNAC n (%)	Core Needle Biopsy n (%)	Test value	95% CI	p-value
Adequate sample	87 (87.0%)	96 (96.0%)	χ^2 = 5.21	1.91-15.92	0.022
Inadequate sample	13 (13.0%)	4 (4.0%)			
Definite diagnostic yield	78 (78.0%)	91 (91.0%)	χ^2 = 6.49	3.11-22.89	0.011
Indeterminate result	17 (17.0%)	6 (6.0%)	χ^2 = 5.85	2.44-19.56	0.016
Mean number of repeat procedures required	0.24 ± 0.46	0.08 ± 0.27	t = 3.01	0.05-0.27	0.003

The adequacy and diagnostic yield were significantly better with Core Needle Biopsy compared to FNAC. Adequate samples were obtained in 96.0% of cases using Core Needle Biopsy, which was significantly higher than the 87.0% adequacy observed with FNAC (χ^2 = 5.21, p = 0.022; 95% CI: 1.91-15.92). Similarly, the definite diagnostic yield was higher in Core Needle Biopsy (91.0%) compared to FNAC (78.0%), showing statistical significance (χ^2 = 6.49, p = 0.011; 95% CI: 3.11-22.89). Indeterminate results were notably lower with Core Needle Biopsy (6.0%) compared to FNAC (17.0%), which was also statistically significant (χ^2 = 5.85, p = 0.016; 95% CI: 2.44-19.56). Additionally, the mean number of repeat procedures required was significantly less in Core Needle Biopsy (0.08 ± 0.27) compared to FNAC (0.24 ± 0.46), indicating better initial diagnostic adequacy (t = 3.01, p = 0.003; 95% CI: 0.05-0.27).

Table 3: Sensitivity, Specificity and Overall Diagnostic Performance

Diagnostic parameter	FNAC %	Core Needle Biopsy %	Test value	95% CI	p-value
Sensitivity	78.4%	91.9%	Z = 2.12	2.04-25.00	0.034
Specificity	90.5%	96.8%	Z = 1.46	-1.98-14.68	0.144
Positive predictive value	82.9%	94.4%	Z = 1.89	-0.42-23.42	0.058
Negative predictive value	87.7%	95.3%	Z = 1.72	-1.06-16.26	0.085
Overall diagnostic accuracy	86.0%	95.0%	χ^2 = 4.71	1.82-16.18	0.030

Core Needle Biopsy exhibited higher sensitivity, specificity, and overall diagnostic performance compared to FNAC. The sensitivity of Core Needle Biopsy (91.9%) was significantly higher than FNAC (78.4%) (Z = 2.12, p = 0.034; 95% CI: 2.04-25.00), indicating better detection of true positive cases. Although specificity was higher in Core Needle Biopsy (96.8%) compared to FNAC (90.5%), this difference was not statistically significant (Z = 1.46, p = 0.144; 95% CI: -1.98-14.68). Similarly, the positive predictive value (94.4% vs 82.9%) and negative predictive value (95.3% vs 87.7%) were higher for Core Needle Biopsy, though these differences did not reach statistical significance (p = 0.058 and p = 0.085 respectively). Importantly, the overall diagnostic accuracy was significantly greater with Core Needle Biopsy (95.0%) compared to FNAC (86.0%) (χ^2 = 4.71, p = 0.030; 95% CI: 1.82-16.18).

DISCUSSION

In the present study, Core Needle Biopsy showed significantly higher diagnostic accuracy than FNAC, with correct diagnosis in 95.0% cases compared to 86.0% by FNAC (p=0.030). The mean diagnostic accuracy score was also significantly higher for CNB (9.18±0.91) than FNAC (8.42±1.36; p<0.001). This finding is consistent with Lee et al (2025),[1] and Kim et al (2022),[8] who reported that CNB demonstrated superior diagnostic performance compared to FNAC, particularly in thyroid nodules with suspicious or indeterminate features. Similarly, Osseis et al (2023),[5] observed that while FNAC is a widely accepted first-line investigation, CNB improves diagnostic reliability by providing preserved tissue architecture, which is especially beneficial in follicular-patterned lesions. Jamaiyar et al (2023),[4] and Agrawal et al. (2015),[6] also highlighted that FNAC, though effective, has limitations in

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differentiating certain lesions when compared to histopathological methods.

In terms of adequacy and diagnostic yield, CNB demonstrated better results than FNAC. Adequate samples were obtained in 96.0% cases with CNB compared to 87.0% with FNAC (p=0.022), and definite diagnostic yield was higher with CNB (91.0%) than FNAC (78.0%; p=0.011). Indeterminate results were also lower with CNB (6.0%) compared to FNAC (17.0%; p=0.016). These findings are comparable with Wolinski et al (2017),[2] who in a systematic review and meta-analysis concluded that CNB has a significantly higher diagnostic yield than FNAC. More et al (2025),[3] also reported similar findings, emphasizing that CNB reduces inconclusive results and improves clinical decision-making. Furthermore, Gupta et al. (2018),[9] suggested that core biopsy often "wins the match" over FNAC in terms of diagnostic yield, especially in challenging thyroid lesions.

The present study also showed that repeat procedures were required less frequently with CNB (0.08±0.27) compared to FNAC (0.24±0.46; p=0.003). This supports the observations of Song et al. (2015),[7] who found that cytological techniques alone may require repeat sampling due to inadequate material, whereas CNB provides more definitive results in a single attempt. Similarly, Wang et al (2017),[10] demonstrated that improved sampling techniques lead to better diagnostic adequacy and reduced need for repeat procedures, which aligns with the present findings.

Regarding diagnostic performance, CNB showed higher sensitivity than FNAC (91.9% vs 78.4%; p=0.034), indicating better ability to detect malignant thyroid lesions. Specificity was also higher with CNB (96.8%) compared to FNAC (90.5%), although the difference was not statistically significant. PPV and NPV were similarly higher for CNB. These findings are supported by Lee et al. (2025),[1] and Wolinski et al (2017),[2] who reported improved sensitivity and overall accuracy of CNB over FNAC. However, Sheppard et al. (2021),[11] and Zhang et al (2019),[12] noted that FNAC still maintains high specificity and remains valuable, especially in certain lesion types such as lymphomas, and that the superiority of CNB may vary depending on lesion characteristics and clinical context.

CONCLUSION

The present study demonstrates that Core Needle Biopsy (CNB) is superior to Fine Needle Aspiration Cytology (FNAC) in the evaluation of thyroid lesions in terms of diagnostic accuracy, adequacy of sampling, and overall diagnostic yield. CNB showed significantly higher rates of correct diagnosis, improved sensitivity, and reduced rates of indeterminate and non-diagnostic results compared to FNAC. The ability of CNB to provide preserved tissue architecture contributed to better characterization of thyroid lesions, particularly in cases where FNAC showed limitations, such as follicular-patterned lesions and inconclusive cytology.

Although FNAC remains a valuable, minimally invasive, and cost-effective first-line diagnostic tool, its limitations necessitate adjunctive methods in selected cases. CNB, while slightly more invasive, proved to be more reliable and reduced the need for repeat procedures. Therefore, CNB can be considered a complementary or second-line investigation, especially in cases of non-diagnostic or indeterminate FNAC results.

The integration of both modalities, with FNAC as the initial screening tool and CNB as a problem-solving technique, may provide the most effective diagnostic approach for thyroid nodules, thereby improving clinical decision-making and patient outcomes.

Limitations of the Study

1. The sample size was limited to 100 patients, which may restrict the generalizability of the findings.
2. The study was conducted at a single tertiary care center, which may not reflect wider population variability.
3. Not all cases had histopathological confirmation, which could affect the assessment of true diagnostic accuracy.
4. Operator dependency in performing FNAC and CNB may have influenced the adequacy and results.
5. Potential selection bias due to inclusion of patients who underwent both procedures.
6. Short duration of follow-up limited assessment of long-term diagnostic outcomes.
7. Cost-effectiveness analysis between FNAC and CNB was not evaluated.
8. Complication rates associated with CNB were not extensively analyzed.
9. Inter-observer variability among pathologists was not assessed.
10. The study did not stratify results based on nodule size, location, or ultrasound risk categories.

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