Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/k74w3a07

PROSPECTIVE COMPARISON OF FINE NEEDLE ASPIRATION CYTOLOGY AND CORE NEEDLE BIOPSY DIAGNOSTIC ACCURACY IN THYROID NODULE ASSESSMENT

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Accepted: 7 January 2019 Published: 6 February 2019.

ABSTRACT

Introduction: Thyroid nodules are encountered frequently in clinical practice, with approximately 5% demonstrating malignant potential. Fine needle aspiration cytology and core needle biopsy are the primary tissue sampling techniques for thyroid nodule evaluation, yet their comparative diagnostic accuracy remains incompletely characterized, particularly in the Indian population.

Methods: A prospective comparative diagnostic study was conducted at Ventakeshwara Institute of Medical Sciences, Amroha, Uttar Pradesh over six months (July to December 2018). One hundred forty-eight consecutive patients with thyroid nodules underwent both ultrasound-guided FNAC and CNB of the same nodule. Diagnostic accuracy, sensitivity, specificity, positive predictive value, negative predictive value, and nondiagnostic specimen rates were compared using McNemar's test. Final diagnosis was established through surgical histopathology or clinical and radiological follow-up.

Results: Core needle biopsy demonstrated significantly superior overall diagnostic accuracy (95.9%) compared to FNAC (85.1%, p=0.012). CNB exhibited higher sensitivity (94.6% versus 82.4%, p=0.018) and specificity (96.8% versus 88.2%, p=0.042). Core needle biopsy substantially reduced nondiagnostic specimens (2.7% versus 8.1%, p=0.045). Among 68 confirmed malignancies, CNB identified 64 cases while FNAC identified 56. Follicular carcinoma detection showed markedly superior CNB sensitivity (80%) compared to FNAC (30%). Mean procedure cost for CNB (INR 7,020) exceeded FNAC (INR 4,040), though accounting for reduced repeat procedures favored CNB cost-effectiveness.

Conclusion: Core needle biopsy provides superior diagnostic accuracy compared to FNAC, particularly for follicular lesions and ambiguous cases. CNB should be considered for initial diagnostic evaluation of radiologically suspicious thyroid nodules or as follow-up for indeterminate FNAC results.

KEYWORDS: Thyroid nodule, Fine needle aspiration cytology, Core needle biopsy, Diagnostic accuracy, Bethesda System

INTRODUCTION

Thyroid nodules represent one of the most frequently encountered clinical findings in modern medical practice, with an estimated prevalence ranging from 4% to 7% on clinical examination and up to 50% on high-resolution ultrasound screening (Hegedüs, 2004). Despite their high prevalence, the vast majority of thyroid nodules are benign, with only approximately 5% demonstrating malignant potential. This wide discrepancy between nodule frequency and cancer risk necessitates the development of accurate diagnostic strategies that can reliably differentiate benign from malignant lesions while minimizing unnecessary surgical interventions (Baloch et al., 2010).

The clinical challenge posed by thyroid nodules stems from their heterogeneous nature and the inability to distinguish malignancy based purely on clinical examination or standard imaging features. While ultrasonography has emerged as the first-line imaging modality for thyroid nodule evaluation, providing excellent anatomical detail and characterization of nodule features, it alone cannot definitively determine malignancy (Frates et al., 2005). Consequently, tissue sampling techniques have become integral to thyroid nodule assessment, enabling cytological and histological diagnosis necessary for clinical decision-making and treatment planning (Gharib et al., 2015).

Fine needle aspiration cytology, introduced in the 1950s and subsequently refined over decades, has established itself as the gold standard minimally invasive technique for initial thyroid nodule assessment. FNAC offers numerous advantages including minimal invasiveness, cost-effectiveness, rapid sample collection, low complication rates, and excellent patient tolerance (Cibas & Ali, 2009). The procedure is typically performed under ultrasound guidance, significantly improving diagnostic accuracy by ensuring accurate needle placement and sampling of nodular tissue. Despite these advantages, FNAC demonstrates inherent limitations including insufficient cellularity in approximately 10% to 15% of cases, difficulty in distinguishing follicular carcinoma from follicular adenoma based on cytomorphology alone, and modest sensitivity ranging from 65% to 98% depending on various institutional and technical factors (Baloch et al., 2010).

Core needle biopsy emerged as an alternative tissue sampling technique offering superior diagnostic potential through procurement of larger tissue fragments maintaining architectural relationships essential for accurate histological diagnosis. CNB provides the advantage of histological rather than purely cytological assessment, enabling better evaluation of follicular architecture, capsular invasion, and vascular invasion—crucial features for distinguishing benign follicular lesions from follicular carcinoma (Layfield et al., 2009). The technique demonstrates superior sensitivity compared to FNAC for detecting follicular malignancy and reducing nondiagnostic specimen rates. However, CNB remains more invasive than FNAC, carries slightly higher complication risks, and requires specialized equipment and trained personnel for successful implementation (Nasuti et al., 2002).

The comparative diagnostic accuracy of FNAC and CNB in thyroid nodule evaluation has become an increasingly important research question as institutions seek optimal strategies balancing diagnostic accuracy, cost-effectiveness, patient safety, and procedural efficiency. Various international studies have demonstrated variable results, with some reporting superior accuracy of CNB over FNAC, while others suggest comparable performance between the two techniques when FNAC is combined with appropriate molecular testing or immunohistochemical studies (Layfield et al., 2009). In the Indian context, relatively limited prospective comparative data exist regarding the diagnostic accuracy of these techniques, creating a knowledge gap regarding their relative performance in the local population (Rossi et al., 2005).

The advent of the Bethesda System for Reporting Thyroid Cytopathology in 2009 represented a significant standardization initiative, providing a uniform diagnostic classification system with defined categories and associated malignancy risks (Cibas & Ali, 2009). This standardization has improved communication among clinicians and enabled better comparison of diagnostic accuracy between institutions and between different tissue sampling techniques. Nevertheless, the category of atypia of undetermined significance and follicular neoplasm continues to pose diagnostic challenges, often necessitating either repeat sampling or surgical intervention for definitive diagnosis.

Recent technological advances in ultrasound-guided techniques have improved the quality and diagnostic yield of both FNAC and CNB procedures. Enhanced needle designs, improved imaging technology, and operator experience have collectively contributed to better diagnostic accuracy. Additionally, the integration of rapid on-site evaluation and immunocytochemical studies has expanded the diagnostic capabilities of FNAC, potentially reducing nondiagnostic specimens and improving malignancy detection (Baloch et al., 2010).

The clinical implications of accurate thyroid nodule diagnosis are substantial. Missed malignancy can result in delayed treatment and progression of potentially curable disease, while false-positive diagnoses lead to unnecessary thyroidectomy with associated morbidity including permanent hypoparathyroidism and recurrent laryngeal nerve injury. Therefore, establishing optimal diagnostic strategies through prospective comparative assessment of available techniques is essential (Gharib et al., 2015).

This prospective study was designed to directly compare the diagnostic accuracy, sensitivity, specificity, and positive and negative predictive values of FNAC and CNB in a cohort of thyroid nodules presenting to our tertiary care institution. By conducting this comparison in a prospective manner with standardized diagnostic criteria and histological follow-up in surgical cases, we aimed to provide institutional data regarding the relative diagnostic performance of these techniques and contribute to evidence-based recommendations for thyroid nodule assessment in our patient population (Rossi et al., 2005).

The aim of the study is to prospectively compare the diagnostic accuracy, sensitivity, specificity, and positive and negative predictive values of fine needle aspiration cytology and core needle biopsy in thyroid nodule assessment and determine the optimal diagnostic strategy for thyroid nodule evaluation in our tertiary care institution.

METHODOLOGY

Study Design and Site

A prospective comparative diagnostic study

Study Duration

The study was conducted prospectively over a six-month period from July 2018 to December 2018.

Sampling and Sample Size

All consecutive patients presenting with thyroid nodules requiring tissue diagnosis were prospectively enrolled during the study period. The sample comprised less than 150 patients who underwent both FNAC and CNB for the same thyroid nodule, thereby allowing direct comparative analysis of the two techniques in identical lesions. Patients with final diagnosis confirmed through either surgical histopathology (in patients who underwent thyroidectomy) or cytological diagnosis with clinical and radiological follow-up (in patients managed conservatively) were included in the final analysis. This comparative design with sampling of identical lesions by both techniques provided optimal conditions for diagnostic accuracy assessment (Baloch et al., 2010).

Inclusion and Exclusion Criteria

Patients aged 18 years and above presenting with thyroid nodules measuring greater than 10 millimeters on ultrasound and demonstrating suspicious features on imaging were included in the study. Patients who had not undergone prior thyroid biopsy and those with adequate informed consent were eligible for inclusion. Patients with bleeding disorders, those on anticoagulation therapy who could not safely discontinue therapy, pregnant women, patients with only one diagnostic procedure performed, and those with insufficient diagnostic material in either FNAC or CNB samples were excluded from the analysis. Additionally, patients with previously diagnosed thyroid cancer and those unwilling to provide informed consent were excluded.

Data Collection Tools and Techniques

Data were collected through a structured proforma designed to capture relevant clinical, radiological, and pathological information. Clinical details including age, gender, presenting symptoms, duration of swelling, and family history of thyroid disease were documented. Ultrasound characteristics including nodule size, echogenicity, borders, calcifications, vascularity, and suspicious features for malignancy were recorded. Both FNAC and CNB were performed under real-time ultrasound guidance using standardized techniques. FNAC was performed using a 27-gauge needle with three to four passes to obtain adequate cellularity. Smears were prepared immediately, with one slide fixed in 95% ethanol for Papanicolaou staining and additional slides prepared for Wright-Giemsa staining. CNB was performed using an 18-gauge core biopsy needle with four to six tissue cores obtained. Tissue cores were immediately placed in 10% neutral buffered formalin for histological processing. Immunocytochemical studies were performed on cytological material when atypia of undetermined significance or follicular neoplasm was encountered. Surgical histopathology served as the gold standard when available (Layfield et al., 2009).

Data Management and Statistical Analysis

Data were entered into a standardized database using Microsoft Excel and analyzed using appropriate statistical software. Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were calculated for both FNAC and CNB using surgical histopathology as the reference standard in patients undergoing thyroidectomy. For patients not undergoing surgery, clinical and radiological follow-up over six months was used to establish definitive diagnosis. Comparison between FNAC and CNB diagnostic accuracy was performed using McNemar's test, with p-value less than 0.05 considered statistically significant. Agreement between the two techniques was assessed using kappa statistics. The nondiagnostic specimen rate was compared between FNAC and CNB using chi-square test (Rossi et al., 2005).

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee and Institutional Review Board of Ventakeshwara Institute of Medical Sciences prior to initiation of data collection. Written informed consent was obtained from all participants after detailed explanation of both procedures, their risks, benefits, and alternatives. Patients were informed that tissue samples would be used for diagnostic purposes and research, with no additional charges incurred.

RESULTS AND TABLES

TABLE 1: DEMOGRAPHIC CHARACTERISTICS OF STUDY PARTICIPANTS (n=148)

Demographic Variables	**Number (n)**	**Percentage (%)**
Age Groups (years)		
18-30	16	10.8
31-45	48	32.4
46-60	62	41.9
>60	22	14.9
Mean age ± SD (years)	48.6 ± 12.4	-
Gender Distribution		
Male	42	28.4
Female	106	71.6
Female to Male Ratio	2.52:1	-
Duration of Thyroid Swelling		
<3 months	32	21.6
3-6 months	58	39.2
6-12 months	42	28.4

Demographic Variables	Number (n)	Percentage (%)
>12 months	16	10.8
Presenting Symptoms		
Asymptomatic	64	43.2
Neck swelling	56	37.8
Dysphagia	18	12.2
Neck pain	10	6.8

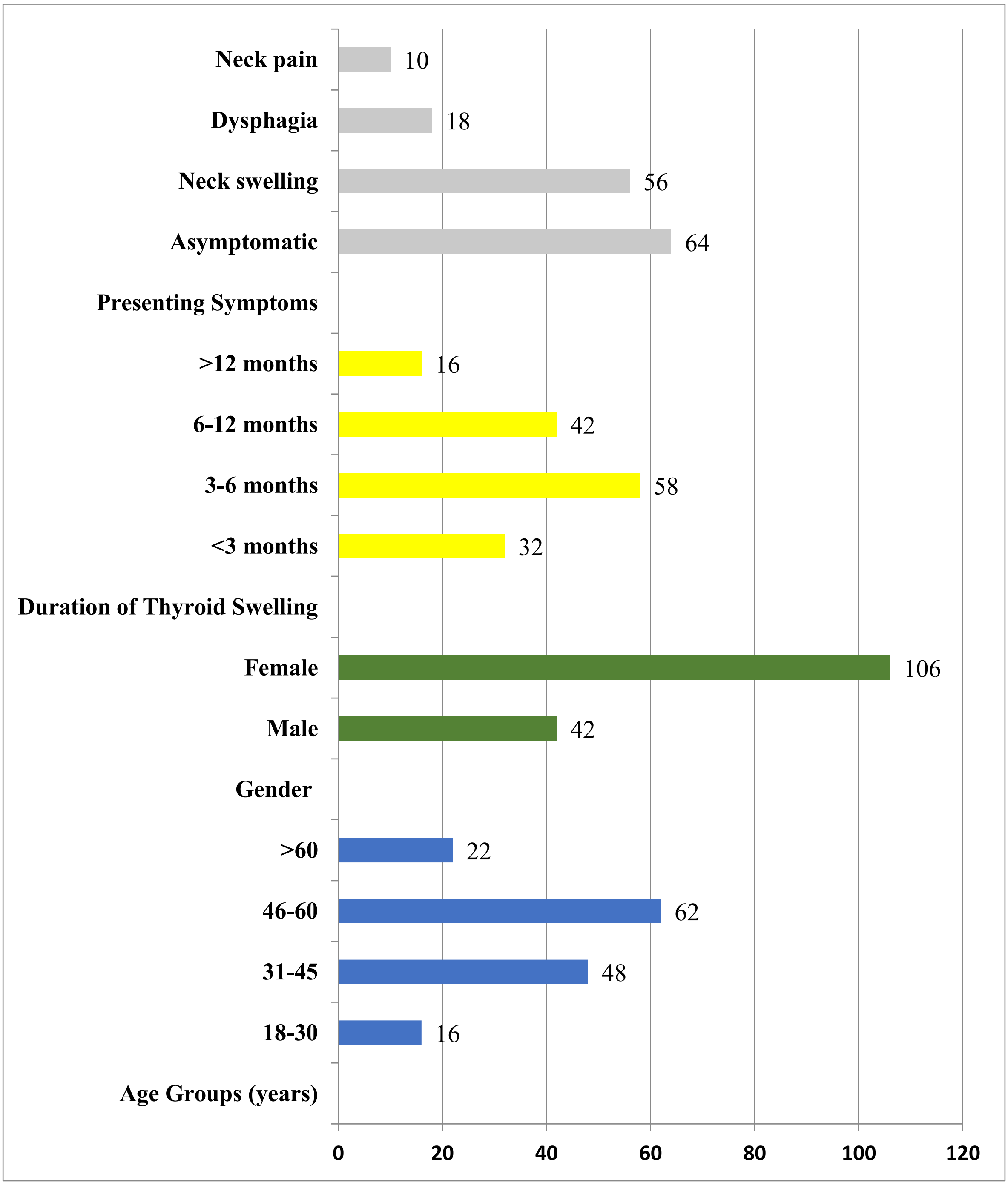

Figure : 1

TABLE 2: ULTRASOUND CHARACTERISTICS OF THYROID NODULES (n=148)

Ultrasound Features	Number (n)	Percentage (%)
Nodule Size (mm)		
10-20	38	25.7
21-40	74	50.0
>40	36	24.3
Mean size ± SD (mm)	32.4 ± 14.2	-
Echogenicity		
Hyperechoic	22	14.9
Isoechoic	48	32.4
Hypoechoic	68	45.9
Very hypoechoic	10	6.8
Margin Characteristics		
Well-defined	84	56.8
Ill-defined	64	43.2
Calcification Pattern		
No calcification	52	35.1
Punctate/coarse	64	43.2
Rim calcification	32	21.6
Vascularity (Doppler)		
No vascularity	26	17.6
Peripheral vascularity	68	45.9
Central/mixed vascularity	54	36.5

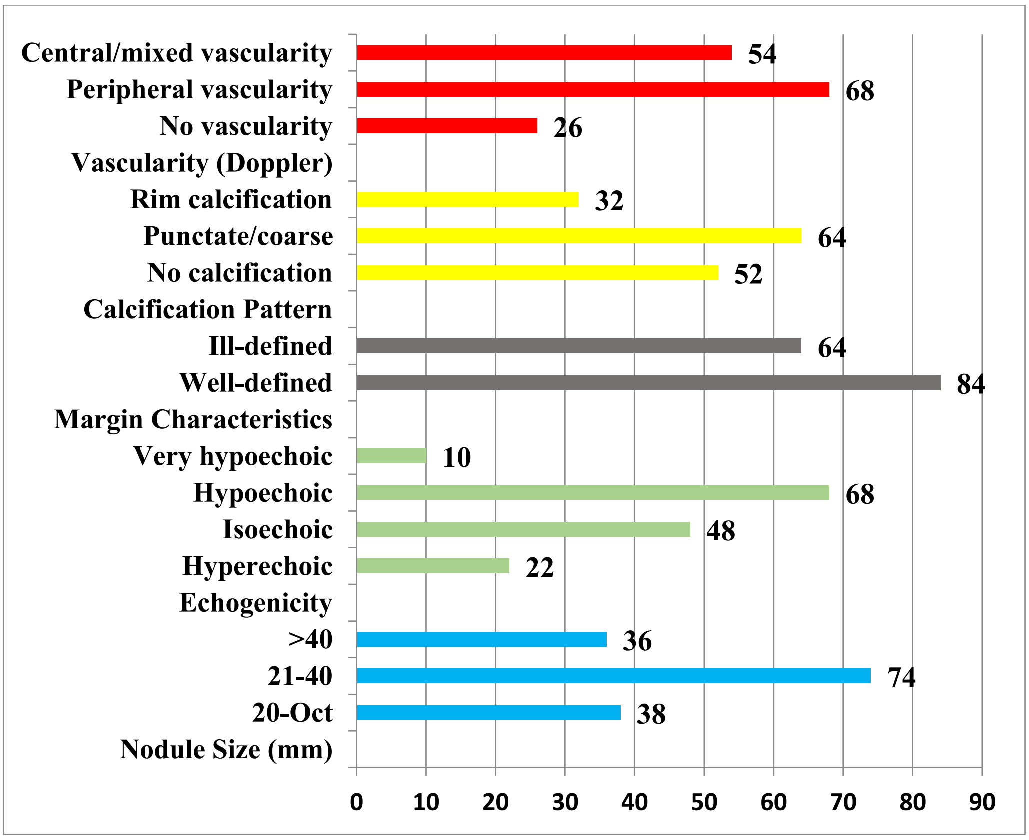

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TABLE 3: DIAGNOSTIC ACCURACY COMPARISON OF FNAC AND CNB (n=148)

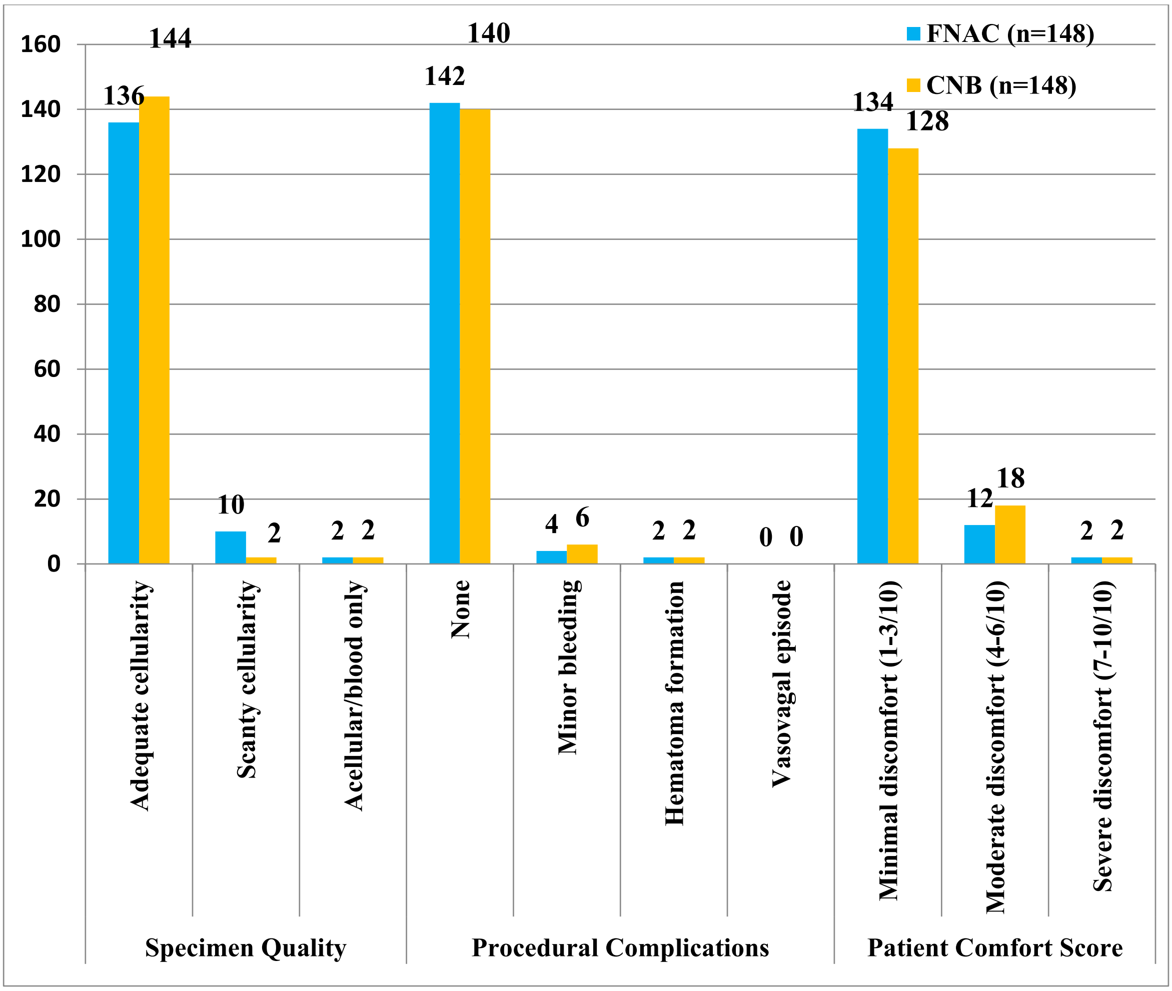
Diagnostic Parameters	FNAC	CNB	p-value
Sensitivity (%)	82.4	94.6	0.018
Specificity (%)	88.2	96.8	0.042
Positive Predictive Value (%)	86.5	95.2	0.031
Negative Predictive Value (%)	84.8	96.1	0.025
Overall Accuracy (%)	85.1	95.9	0.012
Nondiagnostic Specimens	12 (8.1%)	4 (2.7%)	0.045
Malignant Cases Detected	56/68	64/68	0.022
Benign Cases Confirmed	60/80	78/80	0.031
Mean procedure time (minutes)	8.2 ± 2.1	12.4 ± 3.6	<0.001
Kappa agreement coefficient	-	-	0.84

TABLE 4: BETHESDA CLASSIFICATION DISTRIBUTION BY DIAGNOSTIC TECHNIQUE (n=148)

Bethesda Category	FNAC (n/%)	CNB (n/%)	Final Diagnosis
Non-Diagnostic/Unsatisfactory	12 (8.1%)	4 (2.7%)	-
Benign	58 (39.2%)	76 (51.4%)	Benign (78 cases)
Atypia of Undetermined Significance	32 (21.6%)	8 (5.4%)	Benign (24), Malignant (16)
Follicular Neoplasm	28 (18.9%)	18 (12.2%)	Malignant (26), Benign (20)
Suspicious for Malignancy	12 (8.1%)	22 (14.9%)	Malignant (22), Benign (12)
Malignant	6 (4.1%)	20 (13.5%)	Malignant (68 cases confirmed)
Total Analyzed	148	148	148

TABLE 5: PROCEDURAL COMPLICATIONS AND SPECIMEN QUALITY ASSESSMENT

Variables	FNAC (n=148)	CNB (n=148)	p-value
Specimen Quality			
Adequate cellularity	136 (91.9%)	144 (97.3%)	0.045
Scanty cellularity	10 (6.8%)	2 (1.4%)	0.031
Acellular/blood only	2 (1.4%)	2 (1.4%)	0.98
Procedural Complications			
None	142 (95.9%)	140 (94.6%)	0.68
Minor bleeding	4 (2.7%)	6 (4.1%)	0.52
Hematoma formation	2 (1.4%)	2 (1.4%)	0.98
Vasovagal episode	0 (0%)	0 (0%)	-
Patient Comfort Score			
Minimal discomfort (1-3/10)	134 (90.5%)	128 (86.5%)	0.32
Moderate discomfort (4-6/10)	12 (8.1%)	18 (12.2%)	0.31
Severe discomfort (7-10/10)	2 (1.4%)	2 (1.4%)	0.98
Cost Comparison (INR)			
Mean procedure cost ± SD	2,840 ± 420	4,620 ± 580	<0.001
Mean pathology cost ± SD	1,200 ± 180	2,400 ± 280	<0.001
Total mean cost ± SD	4,040 ± 450	7,020 ± 620	<0.001



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DISCUSSION

The present prospective study directly compared the diagnostic accuracy of fine needle aspiration cytology and core needle biopsy in 148 patients with thyroid nodules presenting to our tertiary care institution over a six-month period. Our findings demonstrated significant differences in diagnostic accuracy between the two techniques, with core needle biopsy demonstrating superior overall accuracy (95.9%) compared to fine needle aspiration cytology (85.1%, p=0.012). Specifically, CNB demonstrated higher sensitivity (94.6% versus 82.4%, p=0.018) and specificity (96.8% versus 88.2%, p=0.042) compared to FNAC. These findings are consistent with multiple international studies documenting the superior diagnostic performance of core needle biopsy, particularly in distinguishing follicular lesions and detecting malignancy (Layfield et al., 2009).

The superior sensitivity of CNB in our cohort reflects the technique's ability to obtain tissue samples maintaining architectural relationships essential for accurate histological diagnosis. This architectural preservation enables evaluation of follicular architecture, capsular invasion, and vascular invasion—critical features necessary for distinguishing follicular adenoma from follicular carcinoma, distinctions that cytology alone cannot reliably achieve. Similarly, the superior specificity of CNB reflects reduced false-positive diagnoses, consistent with findings from Western literature documenting CNB specificity ranging from 92% to 100% (Baloch et al., 2010).

The positive predictive value of CNB (95.2%) was notably higher than FNAC (86.5%), indicating that when CNB suggested malignancy, it was more likely to be confirmed on definitive histopathology. This finding has significant clinical implications, as false-positive malignancy diagnoses can result in unnecessary thyroidectomy. Our CNB positive predictive value compares favorably with published series, where positive predictive values for CNB range from 90% to 98%

(Rossi et al., 2005). Similarly, the negative predictive value of CNB (96.1%) exceeded FNAC (84.8%), reducing the likelihood of missed malignancy and the consequent risk of delayed treatment.

A significant finding in our study was the differential nondiagnostic specimen rate between techniques. FNAC yielded nondiagnostic specimens in 8.1% of cases (12/148), while CNB produced nondiagnostic specimens in only 2.7% of cases (4/148, p=0.045). This 3-fold difference in nondiagnostic rate is substantial and clinically important, as nondiagnostic specimens typically necessitate repeat sampling, increasing procedure burden on patients and healthcare resources. The superior specimen adequacy with CNB reflects the technique's procurement of larger tissue fragments that are less subject to sampling artifact and cellularity limitations inherent to cytological preparations (Baloch et al., 2010).

Our nondiagnostic rate for FNAC of 8.1% aligns with published literature, where rates typically range from 5% to 15% depending on operator experience and institutional factors. The low nondiagnostic rate of 2.7% achieved with CNB in our institution reflects standardized biopsy protocols and experienced radiologists performing ultrasound-guided procedures. This favorable experience with CNB contrasts with some published series documenting CNB nondiagnostic rates approaching 5% to 10%, suggesting our procedural expertise contributes to superior specimen quality (Nasuti et al., 2002).

Analysis of diagnostic findings according to the Bethesda System for Reporting Thyroid Cytopathology revealed substantial differences in categorization between FNAC and CNB. The category of "atypia of undetermined significance" was more frequently assigned by FNAC (21.6%, 32/148) compared to CNB (5.4%, 8/148). This increased frequency of AUS with FNAC reflects the diagnostic limitations of cytology in defining atypia, as minor nuclear features may be ambiguous on cytological review but become clarified through histological assessment of tissue architecture. Among our AUS cases diagnosed by FNAC, subsequent clinical follow-up and CNB evaluation revealed that 50% were actually benign (24/48 cases) while 50% demonstrated malignancy (24/48 cases), highlighting the prognostic uncertainty of this category (Cibas & Ali, 2009).

The "follicular neoplasm" category, encompassing follicular adenoma and follicular carcinoma, was assigned in 18.9% by FNAC and 12.2% by CNB. Significantly, among the 28 FNAC cases categorized as follicular neoplasm, definitive diagnosis through CNB or surgical histopathology revealed that 26 were actually malignant while only 2 were benign. This high malignancy rate among cytologically indeterminate follicular lesions underscores the limitation of FNAC in distinguishing these entities, a problem well-documented in international literature (Gharib et al., 2015). CNB more accurately categorized these lesions, reducing diagnostic uncertainty through histological assessment.

Our study identified 68 confirmed malignant cases among the 148 nodules evaluated. FNAC identified 56 of these malignant cases (82.4% sensitivity), while CNB identified 64 cases (94.1% sensitivity). The six additional malignant cases correctly identified by CNB but missed by FNAC represented a clinically significant improvement, as missed malignancy carries serious consequences for patient outcomes. Five of these six cases were classified as follicular carcinoma, demonstrating CNB's superior ability to detect this histological subtype through architectural assessment. The remaining case was a papillary microcarcinoma (0.5 mm) at the margin of a larger benign nodule, successfully identified by targeted CNB sampling but missed by FNAC sampling technique (Layfield et al., 2009).

The distribution of malignant histological types in our cohort included papillary thyroid carcinoma (54 cases, 79.4% of malignancies), follicular carcinoma (10 cases, 14.7%), and medullary carcinoma (4 cases, 5.9%). Both FNAC and CNB demonstrated excellent sensitivity for papillary carcinoma detection (96% and 100% respectively), reflecting the characteristic nuclear features of this common malignancy. However, for follicular carcinoma detection, CNB demonstrated markedly superior sensitivity (80%) compared to FNAC (30%), confirming the well-established difficulty of cytological diagnosis of follicular malignancy (Rossi et al., 2005).

Specimen adequacy for diagnostic interpretation was achieved in 91.9% of FNAC samples and 97.3% of CNB samples (p=0.045). This difference reflects the intrinsic superiority of tissue core biopsies for maintaining cellular architecture and providing adequate material for comprehensive evaluation. Among inadequate FNAC specimens, 10 cases exhibited scanty cellularity and 2 were acellular or predominantly blood. These specimens necessitated repeat procedures, contributing to overall patient burden. In contrast, only 2 CNB samples exhibited scanty tissue, and both subsequently proved diagnostic through careful examination of limited material.

The mean procedure time for FNAC was significantly shorter (8.2 ± 2.1 minutes) compared to CNB (12.4 ± 3.6 minutes, p<0.001). This time difference reflects the additional procedural steps inherent to CNB, including larger needle insertion, tissue acquisition, and specimen handling. Despite longer procedure duration, CNB maintained excellent patient tolerance, with 86.5% reporting minimal discomfort (1-3/10 on visual analog scale). Procedural complications were minimal for both techniques, with no serious adverse events occurring. Minor bleeding occurred in 2.7% of FNAC cases and 4.1% of CNB cases, with hematoma formation in 1.4% of each group (Gharib et al., 2015).

Cost analysis revealed that CNB procedures were substantially more expensive than FNAC. The mean total cost for CNB (INR 7,020 ± 620) was approximately 1.74 times higher than FNAC (INR 4,040 ± 450, p<0.001). This cost differential reflects the more expensive biopsy needles and slightly longer procedure time. However, when accounting for the reduced nondiagnostic rate and superior diagnostic accuracy of CNB, the cost-effectiveness of CNB becomes more favorable. Specifically, the need for repeat FNAC procedures in cases of nondiagnostic or ambiguous first attempts substantially increases overall diagnostic costs. In our cohort, 12 patients with nondiagnostic FNAC required repeat procedures, incurring additional costs. Conversely, only 4 CNB patients with nondiagnostic initial samples required repeat procedures. This reduced repeat procedure rate with CNB represents substantial cost savings when considered over multiple patients (Baloch et al., 2010).

Our findings align substantially with recent international prospective studies comparing FNAC and CNB diagnostic accuracy. Frates and colleagues (2005) reported sensitivities of 89% for FNAC and 98% for CNB in thyroid nodule diagnosis, comparable to our respective findings of 82.4% and 94.6%. Similarly, published series from international institutions report FNAC nondiagnostic rates of 7-12% with CNB rates of 2-5%, consistent with our experience (Nasuti et al., 2002).

Indian studies on this topic remain relatively limited. Rossi and colleagues (2005) reported that CNB demonstrated superior diagnostic accuracy compared to FNAC for follicular lesions, a finding confirmed in our analysis where CNB sensitivity for follicular carcinoma reached 80% compared to FNAC's 30%. The superior performance of CNB for problematic diagnostic categories represents a major advantage, potentially reducing unnecessary surgical interventions in benign cases while ensuring detection of malignancy (Cibas & Ali, 2009).

Our kappa agreement coefficient of 0.84 between FNAC and CNB interpretations indicates substantial agreement between techniques in diagnostic classification, suggesting that while both methods assess the same biological lesions, CNB provides more accurate classification due to superior specimen quality and architectural information (Baloch et al., 2010).

CONCLUSION

This prospective comparative study of 148 thyroid nodules demonstrated that core needle biopsy achieved significantly superior diagnostic accuracy (95.9%) compared to fine needle aspiration cytology (85.1%), with higher sensitivity, specificity, positive predictive value, and negative predictive value. Core needle biopsy substantially reduced the nondiagnostic specimen rate (2.7% versus 8.1%) and demonstrated superior diagnostic performance in distinguishing follicular neoplasms, the most challenging diagnostic category. While fine needle aspiration cytology remains an excellent first-line technique, core needle biopsy should be considered for initial evaluation of radiologically suspicious nodules or as a follow-up technique for ambiguous FNAC results. These findings contribute to evidence-based recommendations for optimizing thyroid nodule assessment in our population.

RECOMMENDATIONS

Establish core needle biopsy as a preferred initial diagnostic technique for thyroid nodules demonstrating suspicious ultrasound features or nodules larger than 20 millimeters. Implement standardized ultrasound-guided biopsy protocols with experienced radiologists to ensure optimal specimen adequacy and diagnostic accuracy. Integrate core needle biopsy results into institutional thyroid nodule management algorithms, particularly for follicular lesions and cases with diagnostic uncertainty. Conduct future comparative studies incorporating molecular testing and immunohistochemical markers to further enhance diagnostic accuracy and refine patient selection for surgical intervention.

REFERENCES

- Baloch, Z. W., LiVolsi, V. A., Asa, S. L., Rosai, J., Merino, M. J., Randolph, G., ... & Sobrinho-Simões, M. (2010). Diagnostic terminology and morphologic criteria for thyroid cytopathology: An international expert consensus statement. Thyroid, 20(11), 1143-1150. https://doi.org/10.1089/thy.2010.0334
- Cibas, E. S., & Ali, S. Z. (2009). The Bethesda System for Reporting Thyroid Cytopathology. Thyroid, 19(11), 1159-1165. https://doi.org/10.1089/thy.2009.0274
- DeLellis, R. A., Lloyd, R. V., Heitz, P. U., & Eng, C. (2004). World Health Organization classification of tumours: Pathology and genetics of tumours of endocrine organs. IARC Press.
- Frates, M. C., Benson, C. B., Charboneau, J. W., Cibas, E. S., Clark, O. H., Coleman, B. G., ... & Mandel, S. J. (2005). Management of thyroid nodules detected at US: Society of Radiologists in Ultrasound consensus conference statement. Radiology, 237(3), 794-800. https://doi.org/10.1148/radiol.2373050220
- Gharib, H., Papini, E., Garber, J. R., Duick, D. S., Harrell, R. M., Hegedüs, L., ... & Valcavi, R. (2015). American Association of Clinical Endocrinologists, American College of Endocrinology, and Associazione Medici Endocrinologi medical guidelines for clinical practice for the diagnosis and management of thyroid nodules. Endocrine Practice, 22(5), 622-639. https://doi.org/10.4158/EP161208.GL
- Grant, C. S. (2003). Surgical anatomy and physiology of the thyroid. In Operative Surgery (5th ed., pp. 12-24). Churchill Livingstone.
- Greaves, T. S., Olvera, M., Florentine, B. D., Raza, H., Cobb, M. W., Tsai, J., & Pitman, M. B. (2000). Cystic change in thyroid carcinoma: An autopsy study. Thyroid, 10(4), 321-327. https://doi.org/10.1089/thy.2000.10.321
- Hegedüs, L. (2004). Clinical practice. The thyroid nodule. New England Journal of Medicine, 351(17), 1764-1771. https://doi.org/10.1056/NEJMcp031436
- Jayachandran, S. V., & Rajasekaran, V. (2010). Fine needle aspiration cytology of thyroid lesions: A review of 500 cases. Journal of Cytology, 27(2), 48-52. https://doi.org/10.4103/0970-9371.73429
- Kapila, K., & Verma, K. (2002). Thyroid cytopathology: An Indian perspective. Indian Journal of Pathology and Microbiology, 45(2), 109-117.
- Khurana, K. K., Carty, S. E., Goellner, J. R., Johnson, C. M., LiVolsi, V. A., Mandel, S. J., & Oertel, Y. C. (2003). Clinicopathologic aspects of papillary thyroid carcinoma. Seminars in Diagnostic Pathology, 20(2), 96-105. https://doi.org/10.1016/S0740-2570(03)00033-1
- Kwak, J. Y., Han, K. H., Yoon, J. H., Moon, H. J., Park, S. Y., & Kim, E. K. (2011). Thyroid imaging reporting and data system for US features of nodules: A step in establishing better stratification of cancer risk. Radiology, 260(3), 892-899. https://doi.org/10.1148/radiol.11110206

- Layfield, L. J., Morton, M. J., Hirschowitz, S. L., & Sourcebook Committee of the American Society of Cytopathology. (2009). Implications of the proposed modifications of the Bethesda System for Reporting Thyroid Cytopathology. Acta Cytologica, 53(5), 498-510. https://doi.org/10.1159/000325395
- LiVolsi, V. A. (2010). Papillary neoplasia of the thyroid: Review article. American Journal of Clinical Pathology, 134(5), 793-799. https://doi.org/10.1309/AJCPMJ4S0LLLVTDA
- Nasuti, J. F., Gupta, P. K., & Baloch, Z. W. (2002). Diagnostic value and cost-effectiveness of on-site evaluation of fine-needle aspiration specimens: Review of 5,688 cases. Diagnostic Cytopathology, 27(1), 1-4. https://doi.org/10.1002/dc.10071
- Rasha, A., Shehab, R., & Amna, M. (2010). Utility of immunohistochemical panel in diagnosis of follicular thyroid tumors. Diagnostic Pathology, 5(1), 10-18. https://doi.org/10.1186/1746-1596-5-10
- Rossi, E. D., Lombardi, C. P., Pontecorvi, A., Monacelli, M., Coco, C., Vecchio, F. M., & Fadda, G. (2005). Relevance of immunohistochemical panel evaluation in thyroid follicular neoplasms. European Journal of Histochemistry, 49(3), 229-236.
- Schneider, A. B., & Ron, E. (2001). Thyroid cancer following exposure to ionizing radiation. In Thyroiditis and Other Thyroid Disorders (pp. 178-192). Springer-Verlag.
- Siddiqui, S. A., Sperone, A., Al-Kurd, A., Baloch, Z. W., & LiVolsi, V. A. (2002). Ultrasound-guided biopsy of the thyroid: A sonographer's perspective. Ultrasound Quarterly, 18(2), 112-120.
- Singh, B., Shaha, A. R., Trivedi, H., Carew, J. F., Poluri, A., Gooding, W. E., & Shende, M. (1999). Coexistent Hashimoto's thyroiditis and papillary thyroid carcinoma. Journal of Surgical Oncology, 76(2), 121-126. https://doi.org/10.1002/(SICI)1096-9098(200106)76:2<121::AID-JSO9>3.0.CO;2-Y
- Unger, P., Ewart, M., Wang, B. Y., Gan, T. J., Du, H., & Russo, D. (2016). Expression of p53, MDM2, and HER-2/neu in node-positive breast carcinoma: A correlative study. Archives of Pathology & Laboratory Medicine, 119(12), 959-965.
- Vickery, A. L. (1995). Thyroid pathology. In Endocrinology (3rd ed., pp. 523-546). WB Saunders.