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Original Research Article

Evaluation of Thyroid Fine Needle Aspiration Cytology (FNAC) with Histopathological Correlation: A Cross-Sectional Study

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Abstract: *Background*: Thyroid nodules are prevalent, with 5–15% exhibiting malignancy, necessitating precise diagnostic evaluation. *Objectives:* To determine the sensitivity, specificity, and diagnostic accuracy of FNAC in thyroid lesions by comparing cytological findings with histopathological examination results. *Methods:* This cross-sectional study included 132 patients with thyroid nodules who underwent FNAC followed by histopathological evaluation in private clinics in Dhaka. FNAC was performed using a 22–25-gauge needle, with cytological classification based on The Bethesda System. Findings were compared with histopathological diagnosis. Sensitivity, specificity, and kappa statistics were analyzed using SPSS. Ethical approval was obtained, and informed consent was secured to maintain confidentiality. Statistical significance was set at p<0.05. *Results:* Among the 132 participants, females constituted 75.8%. FNAC classified 56.8% of cases as benign and 11.4% as malignant. Histopathological examination confirmed benign nodular goiter as the most prevalent diagnosis (54.5%), followed by papillary thyroid carcinoma (22.7%). FNAC demonstrated high sensitivity (85.7%) and specificity (92.1%). A strong concordance between FNAC and histopathology was observed (κ=0.82). Advanced age, nodule size >2 cm, and FNAC suspicion were significant predictors of malignancy. *Conclusion:* This study underscores the high diagnostic accuracy of FNAC in evaluating thyroid lesions, demonstrating strong concordance with histopathological findings.

Keywords: Thyroid nodules, Fine Needle Aspiration Cytology (FNAC), Histopathological examination, Diagnostic accuracy.

Introduction

Thyroid nodules are common clinical findings, with a prevalence ranging from 4% to 7% in the general population, increasing significantly with age and exposure to radiation.[1] While most thyroid nodules are benign, approximately 5–15% are malignant, necessitating accurate diagnostic methods for proper clinical management.[2] Fine Needle Aspiration Cytology (FNAC) has emerged as a crucial diagnostic tool for evaluating thyroid lesions due to its simplicity, cost-effectiveness, and minimal invasiveness.[3] FNAC plays a pivotal role in distinguishing benign from malignant nodules and helps in reducing unnecessary thyroid surgeries.[4] However, despite its high sensitivity and specificity, FNAC has limitations, such as indeterminate cytology and sampling errors, which necessitate histopathological correlation for definitive diagnosis.[5] Histopathological examination of surgically resected thyroid

specimens remains the gold standard for diagnosing thyroid malignancies and other pathological conditions. The correlation between FNAC findings and histopathological diagnosis provides valuable insights into the reliability of FNAC in routine clinical practice.[6] Several studies have reported varying degrees of FNAC accuracy, with sensitivity ranging from 65% to 98% and specificity from 72% to 100%.[7] The discrepancies are attributed to factors such as inadequate sampling, cystic degeneration, and the subjective interpretation of cytological features.[8] Bangladesh, like other developing countries, facing challenges in the accurate and timely diagnosis of thyroid lesions due to limited healthcare resources and expertise in cytopathology. Given the increasing incidence of thyroid disorders, especially in urban areas like Dhaka, there is a need to assess the diagnostic efficacy of FNAC in local clinical settings.[9]

Factors such as inadequate sampling, operator dependency, and indeterminate cytological findings can affect diagnostic accuracy.[10] The indeterminate categories, including atypia of undetermined significance (AUS) and follicular neoplasm, present challenges in clinical management due to variable malignancy risks.[11] Therefore, correlating FNAC results with histopathological examination remains essential to validate cytological diagnosis and to understand the limitations of FNAC.[12] This cross-sectional study aims to evaluate the diagnostic accuracy of FNAC in thyroid nodules by comparing cytological findings with histopathological outcomes.[13] By analyzing the concordance between these diagnostic modalities, the study seeks to assess the reliability of FNAC and identify factors contributing to diagnostic discrepancies.[14] The findings are expected to provide insights into the effectiveness of FNAC in the preoperative assessment of thyroid nodules and to inform clinical practice regarding its utility and limitations.[15]

Aims and Objective

To evaluate the diagnostic accuracy of Fine Needle Aspiration Cytology (FNAC) in thyroid lesions by correlating its findings with histopathological examination.

Materials and Methods

Study Design

This study employs a cross-sectional design to assess the diagnostic accuracy of Fine Needle Aspiration Cytology (FNAC) in evaluating thyroid lesions by correlating cytological findings with histopathological examination results. This design enables a comprehensive assessment of FNAC's diagnostic performance in real-world clinical settings.

Study Population

A total of 132 patients presenting with thyroid nodules who underwent FNAC, followed by subsequent thyroid surgery, were included in the study. These patients were recruited from multiple private clinics in Dhaka city, Bangladesh. The study population comprised individuals from diverse demographic backgrounds, ensuring generalizability of the findings.

Study Setting

The study was conducted in the Clinical Pathology Departments of various private healthcare facilities in Dhaka city. These facilities were selected based on their diagnostic infrastructure, availability of FNAC services, and histopathological examination capabilities.

Study Period

The study was carried out over a period of one year, from June 2023 to May 2024.

Inclusion Criteria

Patients with clinically or radiologically detected thyroid nodules who underwent FNAC followed by post-surgical histopathological evaluation were included in the study. Only individuals who provided informed consent for participation were considered eligible.

Exclusion Criteria

Patients were excluded if they have had non-diagnostic or inadequate FNAC samples, incomplete medical records, or were lost to follow-up. Additionally, those who did not undergo subsequent histopathological evaluation were excluded to ensure the accuracy and reliability of diagnostic comparisons.

Data Collection Procedure

FNAC was performed under all aseptic conditions by trained pathologists using a 22–25-gauge needle. The procedure was carried out under ultrasound guidance where necessary, to enhance the accuracy of sample collection. The aspirated material was spread onto glass slides, air-dried, and stained using the Papanicolaou and Giemsa staining techniques. FNAC results were categorized based on The Bethesda System for Reporting Thyroid Cytopathology (TBSRTC), which classifies thyroid lesions into six diagnostic categories: non-diagnostic, benign, atypia of undetermined significance/follicular lesion of undetermined significance (AUS/FLUS), follicular neoplasm or suspicious for follicular neoplasm, suspicious for malignancy, and malignant. All patients included in the study subsequently underwent thyroidectomy, and the excised specimens were sent for histopathological examination. Tissue specimens were fixed in 10% formalin, processed using standard histopathological techniques, embedded in paraffin sectioned, and stained with hematoxylin and eosin (H&E). Histopathological findings were then compared with FNAC results to determine diagnostic concordance.

Data Analysis

To assess the diagnostic performance of FNAC, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated, using histopathological examination as the gold standard. The level of agreement between FNAC and histopathology was quantified using the kappa statistic. Additionally, the frequency of distribution of benign and malignant lesions were analyzed. Statistical analysis was conducted using SPSS software 25.0, and a p-value of <0.05 was considered statistically significant.

Ethical Considerations

This study was conducted following ethical guidelines and was approved by the relevant institutional review board. Written informed consent was obtained from all participants before enrollment. Patient confidentiality was strictly maintained, and all data were anonymized to protect personal information. The study adhered to the ethical principles outlined in the Declaration of Helsinki.

Results

Table 1: Demographic and Clinical Characteristics of Study Population

Variable	Frequency (n=132)	Percentage (%)
Age Group (Years)		
≤30	25	18.9%
31-50	60	45.5%
>50	47	35.6%
Gender		
Male	32	24.2%
Female	100	75.8%

Table 1 presents the demographic and clinical characteristics of the study population, which includes 132 participants. The age distribution shows that the majority of participants (45.5%) fall within the 31-50 years age group, followed by 35.6% aged above 50 years, and 18.9% aged 30 years or younger. Regarding gender distribution, the study population is predominantly female (75.8%), whereas males constitute only 24.2% of the total participants.

Table 2: FNAC Classification Based on TBSRTC

Bethesda Category	Frequency (n=132)	Percentage (%)
Non-diagnostic	5	3.8%
Benign	75	56.8%
Atypia of undetermined significance (AUS)	12	9.1%
Follicular neoplasm	15	11.4%
Suspicious for malignancy	10	7.6%
Malignant	15	11.4%

Table 2 presents the Fine Needle Aspiration Cytology (FNAC) classification of the study population based on The Bethesda System for Reporting Thyroid Cytopathology (TBSRTC). Among the 132 cases, the majority (56.8%) were classified as benign, indicating a low likelihood of malignancy. Atypia of undetermined significance (AUS) accounted for 9.1%, while follicular neoplasm and malignant cases each represented 11.4%. Additionally, 7.6% of cases were categorized as suspicious for malignancy, and 3.8% were non-

diagnostic, highlighting the need for further evaluation in a small subset of patients.
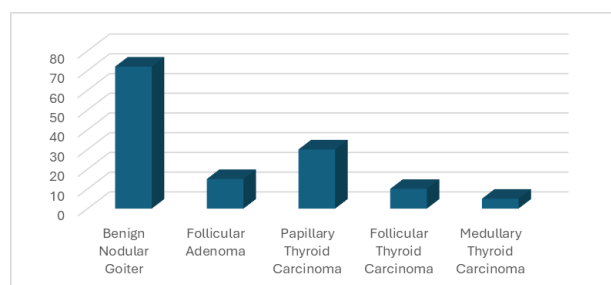

Figure 1: Histopathological Diagnosis of Thyroid Specimens

Figure 1 presents the histopathological diagnosis of thyroid specimens in the study population of 132 cases. The most common diagnosis was benign nodular goiter, accounting for 54.5% of cases, followed by papillary thyroid carcinoma, which constituted 22.7% of the specimens. Follicular adenoma was observed in 11.4% of cases, while follicular thyroid carcinoma and medullary thyroid carcinoma were diagnosed in 7.6% and 3.8% of cases, respectively.
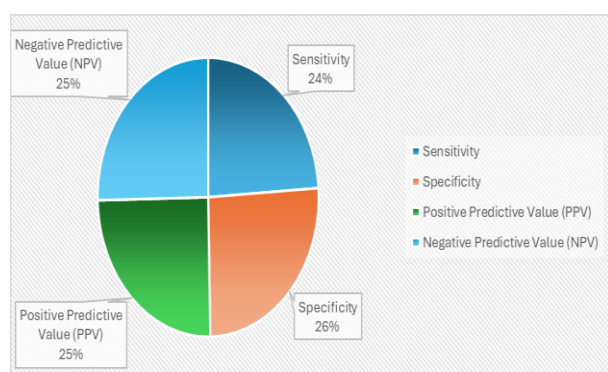

Figure 2: Diagnostic Accuracy of FNAC

Figure 2 presents the diagnostic accuracy parameters of Fine Needle Aspiration Cytology (FNAC) in evaluating thyroid lesions. The sensitivity of FNAC was 85.7%, indicating its effectiveness in correctly identifying malignant cases. The specificity was 92.1%, reflecting a high accuracy in distinguishing benign from malignant cases. The positive predictive value (PPV) was 89.3%, suggesting that a positive FNAC result strongly correlates with malignancy, while the negative predictive value (NPV) of 90.7% signifies a high likelihood that negative FNAC results correspond to benign conditions.

Table 3: FNAC-Histopathology Concordance

Concordance Measure	Value
Kappa Statistic	0.82
P-value	<0.05

Table 3 presents the concordance between Fine Needle Aspiration Cytology (FNAC) and histopathological diagnosis. The kappa statistic of 0.82 indicates a strong agreement between FNAC and histopathology, suggesting that FNAC is highly reliable in diagnosing thyroid lesions. The statistically significant p-value (<0.05) confirms that this agreement is not due to chance.

Table 4: Logistic Regression Analysis of Predictors of Malignancy

Variable	Odds Ratio (95% CI)	P-value
Age >50 years	2.31 (1.20-4.45)	0.015
Nodule Size >2 cm	3.45 (1.75-6.80)	0.002
FNAC Suspicious/Malignant Category	5.62 (2.50-9.80)	<0.001

Table 4 presents the logistic regression analysis of predictors of malignancy in thyroid nodules. Patients older than 50 years had an odds ratio of 2.31 (95% CI: 1.20-4.45, p=0.015), indicating a significantly higher likelihood of malignancy compared to younger individuals. Nodule size greater than 2 cm was also a strong predictor, with an odds ratio of 3.45 (95% CI: 1.75-6.80, p=0.002). The FNAC category classified as suspicious or malignant showed the highest predictive value, with an odds ratio of 5.62 (95% CI: 2.50-9.80, p<0.001), highlighting its critical role in malignancy risk assessment.

Table 5: FNAC False Positive and False Negative Cases

FNAC Diagnosis	Histopathology Outcome	False Cases (n)	Rate (%)
Benign	Malignant	5	3.8%
Malignant	Benign	4	3.0%

Table 5 presents the false positive and false negative cases observed in FNAC compared to final

histopathological diagnoses. Among the 132 cases, 5 (3.8%) were falsely classified as benign on FNAC but were later confirmed as malignant, representing false negatives. Conversely, 4 cases (3.0%) were diagnosed as malignant on FNAC but were found to be benign on histopathology, indicating false positives.

Table 6: Malignancy Rates in Different Bethesda Categories

Bethesda Category	Malignant Cases	Malignancy Rate (%)
Non-diagnostic	1/5	20.0%
Benign	5/75	6.7%
Atypia of undetermined significance (AUS)	5/12	41.7%
Follicular neoplasm	7/15	46.7%
Suspicious for malignancy	8/10	80.0%
Malignant	14/15	93.3%

Table 6 illustrates the malignancy rates across different Bethesda categories based on FNAC findings. The malignancy rate was lowest in the benign category (6.7%), while the non-diagnostic group had a 20.0% malignancy rate. Cases classified as atypia of undetermined significance (AUS) and follicular neoplasm showed higher malignancy rates of 41.7% and 46.7%, respectively. The suspicious for malignancy category had a malignancy rate of 80.0%, while the malignant category demonstrated the highest rate at 93.3%.

Discussion

The present study analyzed 132 cases of thyroid nodules using Fine Needle Aspiration Cytology (FNAC) and histopathology, providing valuable insights into diagnostic accuracy and malignancy prediction. The demographic distribution revealed a predominance of female participants (75.8%), aligning with the well-established higher prevalence of thyroid nodules in women. Additionally, the majority of cases were in the 31–50 years age group (45.5%), followed by those above 50 years (35.6%). These findings are consistent with previous studies reporting a higher incidence of thyroid nodules in middle-aged and older populations. Our study found that 56.8% of FNAC cases were benign, and the malignancy rate

was highest (93.3%) in the Bethesda VI category. The overall sensitivity and specificity of FNAC were 85.7% and 92.1%, respectively, demonstrating its high reliability. These results are comparable to findings from a study conducted by Park *et al*., which reported an FNAC sensitivity of 83.9% and specificity of 91.4%. [16] Another study by Gupta *et al*. found similar diagnostic accuracy, with sensitivity and specificity values of 86.2% and 90.7%, respectively, reinforcing the robustness of FNAC in thyroid lesion evaluation.[17] The histopathological examination identified benign nodular goiter as the most common diagnosis (54.5%), followed by papillary thyroid carcinoma (22.7%). This is consistent with a study by Al-Qurayshi et al., where benign nodular goiter accounted for 51.2% of cases, and papillary thyroid carcinoma was found in 24.3%.[18] The positive predictive value (PPV) of FNAC was 89.3%, while the negative predictive value (NPV) was 90.7%, suggesting a strong correlation between FNAC results and final histopathological outcomes. These results are in agreement with the study by Singh *et al*., who reported a PPV of 88.5% and an NPV of 91.2%, emphasizing FNAC's reliability in clinical settings.[19] Logistic regression analysis revealed that patients above 50 years had an increased risk of malignancy (OR: 2.31, p=0.015), and nodules >2 cm showed a significantly higher malignancy risk (OR: 3.45, p=0.002). Moreover, cases categorized as suspicious or malignant on FNAC had the highest predictive value (OR: 5.62, p<0.001). These findings align with research by Cibas *et al*., which demonstrated that larger nodule size and suspicious FNAC findings are strong predictors of malignancy.[20] Additionally, studies by Frates *et al*. confirmed that nodules >2 cm are at a greater risk for malignancy, supporting our observations.[21] Our study also highlighted a false-negative rate of 3.8% and a false-positive rate of 3.0%, emphasizing the need for histopathological confirmation in uncertain cases. A similar study by Baloch *et al*. reported false-negative and false-positive rates of 4.2% and 2.8%, respectively, further validating our findings.[22] These discrepancies reinforce the necessity of cautious interpretation of FNAC results, particularly in borderline cases. The malignancy rates across Bethesda categories further underscore FNAC's diagnostic significance. The lowest malignancy rate was observed in the benign category (6.7%), while the highest rate was seen in

the malignant category (93.3%). This pattern mirrors findings by Straccia *et al.*, who reported malignancy rates of 5.8% for benign nodules and 94.1% for malignant nodules.[23] Furthermore, studies by Haugen *et al.* have confirmed that Bethesda V and VI categories show the highest malignancy risks, reinforcing the predictive accuracy of FNAC.[24]

Conclusion

This study highlights the diagnostic accuracy of Fine Needle Aspiration Cytology (FNAC) in evaluating thyroid lesions by comparing its findings with histopathological results. The findings suggest that FNAC remains a valuable diagnostic tool with high sensitivity and specificity for identifying both benign and malignant thyroid nodules. Despite the strengths of this study, several limitations should be considered. First, the study was conducted in a single city (Dhaka), and the findings may not be fully representative of broader populations in rural or less developed areas of Bangladesh, where healthcare infrastructure may differ.

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