

Diagnostic Utility of Thyroid FNAC in the Assessment of Thyroid Lesions - A Retrospective Analysis

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Abstract:

Background: Fine Needle Aspiration Cytology (FNAC) is the gold-standard preoperative diagnostic tool for evaluating thyroid nodules. This retrospective study assessed the diagnostic utility of thyroid FNAC at our center.

Methods: We analyzed 150 patients who underwent thyroid FNAC over the study period. Cyto-histological correlation was available for 56 surgical cases. Diagnostic performance metrics were calculated using two analytical approaches: excluding suspicious cases and including them as malignant.

Results: Females predominated (132, 88.0%), with a female-to-male ratio of 7.3:1. Benign lesions comprised 132 (88.0%) FNAC specimens, with colloid goitre (87, 58.0%) being the most common diagnosis. Malignant lesions accounted for 18 (12.0%), predominantly papillary carcinoma (10, 6.67%). Bethesda Category II (Benign) constituted 77.33% of cases. Cyto-histological concordance for benign and malignant categories was 100% and 92.31%, respectively. Excluding suspicious cases, FNAC demonstrated sensitivity of 70.59%, specificity of 97.06%, PPV of 92.31%, NPV of 86.84%, and diagnostic accuracy of 88.24%. Including suspicious cases as malignant yielded sensitivity of 76.19% and specificity of 94.29%.

Conclusion: Thyroid FNAC is a highly reliable preoperative diagnostic tool with excellent specificity and positive predictive value. The high concordance of benign and malignant categories supports clinical decision-making. Indeterminate categories require adjunctive evaluation. Regular cyto-histological correlation audits are essential for maintaining diagnostic quality.

Keywords: Thyroid nodules, Thyroid FNAC, Goitre, Thyroid lesions.

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Introduction

Thyroid nodules are common clinical findings, detected in up to 67% of the general population on ultrasound or autopsy [1]. Prevalence increases with age, female sex, and higher body mass index. A subset of these nodules, between 5% and 10%, carries a risk of malignancy [2]. Accurate preoperative characterization is therefore a clinical priority.

Fine needle aspiration cytology (FNAC) is the primary preoperative tool for evaluating thyroid nodules. It is minimally invasive, cost-effective, and rapid. Reported sensitivity ranges from 65% to 98%, and specificity from 73% to 100% [3]. Clinicians use FNAC to distinguish benign from malignant lesions and to reduce unnecessary surgical procedures.

The Bethesda System for Reporting Thyroid Cytopathology (TBSRTC), revised in 2023,

standardizes FNAC reporting into six diagnostic categories: non-diagnostic, benign, atypia of undetermined significance (AUS), follicular neoplasm (FN), suspicious for malignancy (SFM), and malignant [4]. Each category carries a defined risk of malignancy and guides clinical management. It facilitates structured communication between cytopathologists and treating clinicians.

Thyroid cancer carries a significant and growing global burden. The Global Burden of Disease Study 2021 reported an estimated 2 million prevalent cases and 44,800 deaths worldwide [5]. Rising rates of incidental detection through neck imaging continue to increase referral volumes for cytological evaluation.

FNAC performance varies across institutions. Retrospective analyses offer real-world data on

diagnostic accuracy, non-diagnostic rates, and cytohistological concordance. This study analyzes thyroid FNAC cases from our institution, correlates cytological findings with histopathological outcomes, and assesses diagnostic performance using the 2023 TBSRTC framework.

Materials & Methods:

This retrospective study has been carried out in the department of pathology of Government Medical College, Saharanpur, UP, India and a total 150 patients are included from November 2023 to November 2025. The study was conducted after required ethical clearance from the college ethical committee. Informed written consent was obtained from all study participants before involving participant in the study.

Inclusion Criteria: All the patients with thyroid swelling irrespective of age and gender.

Exclusion Criteria: Patients with tender thyroid swelling present from a short duration and accompanied with fever. In addition, patients with prior thyroid surgery were excluded.

Procedure:

Various clinical details of the swelling are noted as size, involvement of one lobe, both lobes or entire gland, consistency, mobility and duration since when the swelling was present. FNAC was performed by using a 23-gauge needle attached to a disposable 10ml syringe.

The colour, consistency, nature and amount of the aspirate (in case of fluid) was noted. The aspirated material was expressed onto slides and smears were prepared, 1-2 of the smears were immediately dipped in a jar of 95% ethyl alcohol for Papanicolaou (PAP) stain and remaining 3-4 smears were air-dried and stained by May-Grunwald-Giemsa Stain. FNAs were reported using TBSRTC and results were categorised as [12]:

1. Non-diagnostic or Unsatisfactory
2. Benign

3. Atypia of Undetermined Significance or Follicular Lesion of Undetermined Significance
4. Follicular Neoplasm or Suspicious for a Follicular Neoplasm,
5. Suspicious for Malignancy
6. Malignant.

Out of total 150 cases thyroidectomy specimen's partial as well as total thyroidectomy, only in 56 cases were available for histopathological evaluation. A senior pathologist examined the gross specimens and selected representative sections. We processed tissues and embedded them in paraffin blocks. Gross morphological features of all the 56 specimens were documented and after routine histopathological processing, 3-5-micron thick tissue sections were obtained and stained with H&E stain and histological examination done. Then cytological and histopathological findings were correlated.

Statistical Analysis: IBM SPSS Statistics (version 26.0) was used for all analyses. The diagnostic performance of FNAC was evaluated against the histopathological gold standard. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated for each Bethesda category. Categorical variables as frequencies and percentages. P-value less than 0.05 is considered as significant.

Observations

A total of 150 patients presenting with thyroid lesions underwent preoperative Fine Needle Aspiration Cytology (FNAC) during the study period and were included in the final analysis. Out of these, only 56 underwent through surgery and subsequently for histopathological diagnosis. Among 150 patients, females predominated (132, 88.0%) over males (18, 12.0%), yielding a female-to-male ratio of 7.3:1, consistent with the expected higher prevalence of thyroid nodules in women (Table 1).

Table 1: Gender-wise Distribution of cases (N =150)

Parameter	Category	Count	Percentage
Gender	Male	18	12.00
	Female	132	88.00

The maximum number of patients (53, 35.33%) were in the 21–30 years age group, followed by 39 (26.00%) in the 31–40 years group. Females predominated across all age groups, with the highest female representation (47, 31.33%) in the 21–30 years' cohort (Table 2).

Table 2: Age-wise Distribution of cases (N =150)

S No.	Age Group (in Years)	Total		Male		Female	
		Count	%	Count	%	Count	%
1	10-20	6	4.00%	1	0.67%	5	3.33%
2	21-30	53	35.33%	6	4.00%	47	31.33%
3	31-40	39	26.00%	4	2.66%	35	23.33%

4	41-50	21	14.00%	5	3.33%	16	10.67%
5	51-60	26	17.33%	1	0.67%	25	16.67%
6	>60	5	3.34%	1	0.67%	4	2.67%
Total		150	100.00%	18	12.00%	132	88.00%

Among 150 FNAC specimens, benign lesions comprised 132 (88.0%), with colloid goitre being the most frequent diagnosis (87, 58.0%), followed by lymphocytic thyroiditis (22, 14.67%). Malignant lesions accounted for 18 (12.0%), predominantly papillary carcinoma (10, 6.67%), while suspicious for malignancy constituted 5 cases (3.33%) (Table 3).

Table 3: Distribution of Cytological diagnosis as Benign and Malignant Cases (N= 150)

Cytological Diagnosis					
Benign Lesions			Malignant Lesions		
Diagnosis	Count	%	Diagnosis	Count	%
Colloid Goitre	87	58.00	Suspicious for malignancy	5	5.33
Lymphocytic Thyroiditis	22	14.67	Papillary Carcinoma	10	4.67
Granulomatous Thyroiditis	3	2.00	Anaplastic Carcinoma	3	2.00
Graves' Disease	2	1.33	-	-	-
Hyperplastic Goitre	7	4.67	-	-	-
Follicular Neoplasm	11	7.33	-	-	-
Total	132	88.00	-	18	12.00

Most cases (116, 77.33%) fell into Category II (Benign), followed by Category VI (13, 8.67%) and Category IV (11, 7.33%). Categories III and V each comprised 5 cases (3.33%), while Category I had no cases (Table 4).

Table 4: Distribution of Cytological diagnosis based in Bethesda Classification (N =150)

S. No.	Diagnostic Categories	Count	%
1	Category I	0	0.00%
2	Category II	116	77.33%
3	Category III	5	3.33%
4	Category IV	11	7.33%
5	Category V	5	3.33%
6	Category VI	13	8.67%
Total		150	100%

Cyto-histological correlation was available for 56 surgical cases. Benign FNAC (Category II) showed 100% concordance (23/23). Malignant (Category VI) demonstrated 92.31% malignant confirmation (12/13). Overall concordance was 62.50% (35/56), with indeterminate categories exhibiting variable correlation rates (Table 5).

Table 5: Cyto-histological Correlation (N = 56)

FNAC Diagnosis	Histopathological Diagnosis		Total	Concordance Rate (%)
	Benign	Malignant		
Benign (II)	23	0	23	100.00%
AUS/FLUS (III)	7	2	9	77.78%
Follicular Neoplasm (IV)	3	3	6	50.00%
Suspicious (V)	1	4	5	20.00%
Malignant (VI)	1	12	13	7.69%
Total	35	21	56	62.50%

Consistency tables, excluding suspicious cases and included them as malignant cases are presented in Table 6.

Table 6: 2x2 Contingency Matrices (N = 56)

	Histopathological Diagnosis				Histopathological Diagnosis		
	Benign	Malignant	Total		Benign	Malignant	Total
FNAC Diagnosis				FNAC Diagnosis			
Benign	33	5	38	Benign	33	5	38
Malignant	1	12	13	Malignant	2	16	18
Total	34	17	51	Total	35	21	56

Note: A: Suspicious Cases (Bethesda Category V) were excluded; B: Suspicious Cases were included as Malignant Cases. Diagnostic performance of FNAC was assessed under two analytical approaches. Excluding suspicious cases, sensitivity was 70.59%, specificity 97.06%, PPV 92.31%, NPV 86.84%, and accuracy 88.24%. When suspicious cases were reclassified as malignant, sensitivity improved to 76.19%, while specificity slightly declined to 94.29%, with comparable accuracy (87.50%) (Table 7).

Table 7: Diagnostic Performance Metrics of Thyroid FNAC

Parameter	Value (When Suspicious Cases were excluded from analysis)	Value (Suspicious Cases were included as Malignant Cases)
Sensitivity	0.7059	0.7619
Specificity	0.9706	0.9429
Positive Predictive Value (PPV)	0.9231	0.8889
Negative Predictive Value (NPV)	0.8684	0.8684
Diagnostic Accuracy	0.8824	0.8750
False Positive Rate (FPR)	0.0294	0.0571
False Negative Rate (FNR)	0.0294	0.0571

Discussion

Thyroid nodules are frequently encountered in clinical practice, with ultrasonography detecting them in up to 68% of the general population.

FNAC serves as the standard preoperative diagnostic tool for evaluating these lesions [6]. This study evaluated the diagnostic utility of thyroid FNAC at our medical college through cyto-histological correlation.

The female predominance observed in our cohort (88.0%) aligns with established epidemiological patterns. Studies consistently report higher thyroid disease prevalence in women, with female-to-male ratios ranging from 3:1 to 7:1 [6]. The peak incidence in the 21–30 years age group corresponds with the reproductive years, when hormonal influences may contribute to thyroid pathology.

The distribution of FNAC diagnoses according to the Bethesda System showed benign lesions (Category II) comprising 77.33% of cases. This proportion is comparable to other institutional series reporting benign cytology in 75–80% of cases [7]. Malignant and suspicious categories (V and VI) accounted for 12.0% of diagnoses, consistent with the expected malignancy rate of 5–15% in thyroid nodules [6].

Cyto-histological correlation in 56 surgical cases demonstrated high concordance for definitive categories. Benign FNAC (Category II) showed 100% concordance with histopathology, exceeding the 85–95% reported in other studies [7,8]. Malignant (Category VI) demonstrated 92.31% concordance, comparable to published rates of 89–100% [6,9].

Indeterminate categories (III and IV) presented diagnostic challenges. Category III (AUS/FLUS) showed 77.78% concordance, while Category IV (Follicular Neoplasm) demonstrated 50.00%. These figures reflect the inherent limitations of cytology

in distinguishing benign from malignant follicular lesions. Recent meta-analyses indicate that molecular testing can improve diagnostic accuracy for indeterminate nodules, with ThyroSeq v3 showing sensitivity of 95% and specificity of 82% [10,11].

Diagnostic performance metrics showed FNAC as a reliable tool. Excluding suspicious cases, sensitivity was 70.59% with specificity of 97.06%. The high specificity and positive predictive value (92.31%) indicate that a malignant FNAC diagnosis reliably predicts malignancy. This aligns with findings from a 2024 study reporting FNAC sensitivity of 92.31% and specificity of 82.08% [12]. Another recent study demonstrated sensitivity of 90% and specificity of 93.94% for thyroid FNAC [8].

When suspicious cases were included as malignant, sensitivity improved to 76.19% with minimal reduction in specificity (94.29%). This approach reflects clinical practice where suspicious cytology often prompts surgical intervention. The comparable diagnostic accuracy (88.24% vs 87.50%) across both analytical approaches suggests that the management of suspicious cases remains appropriate.

The false negative rate of 2.94% (excluding suspicious cases) is within the acceptable range reported in literature. Studies have documented false negative rates of 3–15%, often attributed to cystic lesions, sampling errors, or cytological interpretation challenges [6]. Regular auditing and quality assurance programs help minimize these discrepancies.

The overall concordance rate of 62.50% in our study is lower than some published series. A 2020 study reported concordance rates of 87.9% [7]. This difference likely reflects the high proportion of indeterminate categories in our surgical cohort, as patients with benign cytology are often managed

conservatively without surgery. When considering only definitive categories (II and VI), concordance exceeded 96%.

Ultrasonographic features play an important adjunctive role in thyroid evaluation. A recent study demonstrated that combining ultrasound parameters with FNAC improved diagnostic accuracy, with sensitivity of 83.33% and specificity of 79.14% [13]. The ACR-TIRADS and Bethesda classifications are complementary, and patients with suspicious imaging findings require careful evaluation even with benign cytology [13].

Core-needle biopsy has emerged as an alternative for initially inconclusive FNAC results. A 2024 meta-analysis reported that core-needle biopsy demonstrates superior sensitivity (75.1%) compared to repeat FNAC (56.5%) for indeterminate nodules [14]. This approach may reduce unnecessary surgeries in selected patients.

Limitations of this study include its retrospective design and the relatively small number of surgical cases with histopathological correlation. Selection bias may exist, as patients with benign cytology were less likely to undergo surgery. The single-center nature of the study limits generalizability of findings.

FNAC remains the cornerstone of thyroid nodule evaluation. It provides reliable preoperative diagnosis with excellent specificity. The Bethesda System facilitates standardized reporting and risk stratification. In indeterminate cases, molecular testing and multidisciplinary discussion guide appropriate management. Ongoing quality assurance and cytohistological correlation audits are essential to maintain diagnostic accuracy.

Conclusion

Thyroid FNAC demonstrates excellent diagnostic utility for preoperative evaluation of thyroid lesions. The procedure shows high specificity (97.06%) and positive predictive value (92.31%), confirming its reliability in identifying malignant nodules. Benign FNAC diagnoses correlate perfectly with histopathology, supporting conservative management. Indeterminate categories remain challenging, requiring adjunctive molecular testing and ultra-sonographic correlation. Overall diagnostic accuracy exceeds 88% across analytical approaches. FNAC continues to serve as the gold-standard initial investigation, reducing unnecessary surgeries while ensuring timely identification of thyroid malignancies. Regular cyto-histological correlation audits remain essential for maintaining diagnostic quality and optimizing patient outcomes.

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