Section: Pathology

Original Research Article

CORRELATION OF FINE NEEDLE ASPIRATION CYTOLOGY WITH HISTOPATHOLOGICAL FINDINGS IN THYROID LESIONS WITH SPECIAL EMPHASIS ON DISCORDANT CASES

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Received *: 20/09/2025*
Received in revised form *: 08/11/2025*
Accepted *: 27/11/2025*

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DOI: 10.70034/ijmedph.2026.1.162

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (1); 915-922

ABSTRACT

Background: Thyroid lesions encompass a broad range of benign and malignant conditions. Fine Needle Aspiration Cytology (FNAC) remains the cornerstone for initial evaluation, and the Bethesda System for Reporting Thyroid Cytopathology (TBSRTC) provides standardized terminology and malignancy risk stratification. Correlation with histopathological examination (HPE) is essential to assess diagnostic accuracy and identify potential discrepancies. **Aim:** To evaluate the diagnostic performance of FNAC in thyroid lesions by correlating cytological findings with histopathological diagnoses using the Bethesda System.

Materials and Methods: This retrospective study included 88 patients with thyroid swellings who underwent FNAC followed by surgical excision and histopathological confirmation. Cytological diagnoses were categorized according to TBSRTC (I-VI). Cytology-histology correlation was performed, and diagnostic parameters such as sensitivity, specificity, PPV, NPV, and accuracy were calculated. Statistical analysis employed Fisher's exact and chi-square tests, with significance set at $p< 0.05$.

Results: FNAC and HPE correlation was observed in 74 of 88 cases (84%). There were 3 true positives, 9 false negatives, and no false positives, yielding a sensitivity of 25%, specificity and PPV of 100%, NPV of 89.4%, and overall accuracy of 89.8%. Malignancy risk increased from Bethesda II (8.2%) to IV (42.9%) and VI (100%), demonstrating a significant association between cytology category and final histopathology ($p< 0.001$). False negatives were mainly attributed to geographic misses and unrecognized dual pathology.

Conclusion: FNAC, when interpreted via the Bethesda System, is a reliable, minimally invasive, and highly specific diagnostic technique for thyroid lesions. Although sampling limitations may yield false negatives, the progressive risk gradient across Bethesda categories validates its role in clinical decision-making. Integrating cytology-histology correlation enhances diagnostic confidence and guides optimal surgical management.

Keywords: Thyroid lesions, Bethesda System, Fine Needle Aspiration Cytology, Histopathology, Diagnostic accuracy.

INTRODUCTION

Thyroid disorders are among the most prevalent endocrine diseases worldwide, second only to diabetes mellitus in terms of global prevalence. The thyroid gland, a small but vital organ located in the anterior neck, plays an essential role in regulating metabolism, growth, and development. Lesions of the thyroid encompass a wide spectrum of entities

ranging from non-neoplastic conditions such as nodular goiter and thyroiditis to neoplastic lesions including benign adenomas and malignant carcinomas. The increasing awareness and improved diagnostic imaging have led to a remarkable rise in the detection of thyroid nodules, with palpable nodules present in approximately 4-7% of the adult population and incidental nodules detected in up to 50-60% of ultrasound examinations. However, despite the high frequency of thyroid nodules, only about 5-15% prove to be malignant, necessitating a diagnostic approach that minimizes unnecessary surgical interventions while accurately identifying malignancies requiring definitive management.

Fine Needle Aspiration Cytology (FNAC) has emerged as the cornerstone in the initial evaluation of thyroid swellings due to its simplicity, safety, cost-effectiveness, and high diagnostic accuracy.[1] It serves as a minimally invasive procedure that provides cytological samples for microscopic evaluation, allowing for preoperative categorization of thyroid lesions. FNAC has drastically reduced the number of unnecessary thyroid surgeries and has become an indispensable tool in thyroid pathology workups. However, cytology has inherent limitations-primarily due to sampling errors, inadequate material, or overlapping cytomorphological features between benign and malignant lesions-which necessitate histopathological correlation for definitive diagnosis.[2]

Each Bethesda category correlates with an implied risk of malignancy and has recommended clinical management pathways, ranging from clinical follow-up and repeat aspiration to diagnostic lobectomy or total thyroidectomy. This system has improved communication between cytopathologists and clinicians, ensured consistency in diagnosis, and facilitated appropriate patient management strategies.[3]

Histopathological Examination (HPE) remains the gold standard for the final diagnosis of thyroid lesions. While FNAC provides a preoperative diagnosis, histopathology confirms the cytological findings and reveals features that cannot be appreciated on cytology alone, such as capsular and vascular invasion-critical in differentiating follicular adenoma from follicular carcinoma. Therefore, correlating FNAC results with histopathology not only validates cytological accuracy but also helps assess the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of FNAC in thyroid diagnostics.[4]

Numerous studies globally have reported variable sensitivity and specificity rates for FNAC in thyroid pathology. Sensitivity ranges from 65% to 98%, while specificity ranges from 72% to 100%, depending on the experience of the cytopathologist, quality of sampling, and strict adherence to Bethesda criteria. A high specificity ensures that a diagnosis of malignancy on FNAC almost always represents true malignancy, whereas lower sensitivity highlights the potential for false negatives, often resulting from cystic degeneration, sampling from non-representative areas, or dual pathologies.[5]

Aim

To evaluate the diagnostic performance of Fine Needle Aspiration Cytology (FNAC) in thyroid lesions by correlating cytological findings with histopathological diagnoses using the Bethesda System for Reporting Thyroid Cytopathology.

Objectives

1. To correlate Fine Needle Aspiration Cytology (FNAC) findings with histopathological examination (HPE) in thyroid lesions.
2. To determine the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of FNAC in diagnosing thyroid malignancies.
3. To assess the distribution and malignancy risk associated with different Bethesda categories.

MATERIALS AND METHODS

Source of Data

The data were collected retrospectively from the archives of the Department of Pathology, MIMSR medical college, Latur, including cytology and histopathology records of patients who underwent FNAC and subsequent surgical excision of thyroid lesions.

Study Design

This was a retrospective analytical study correlating FNAC findings with histopathological outcomes based on the Bethesda System.

Study Location

The study was conducted at the Department of Pathology, at tertiary care hospital.

Study Duration

The study covered a period of three years, from July 2022 to July 2025.

Sample Size

A total of 88 cases were included in the study based on availability of both FNAC and corresponding histopathology reports.

Inclusion Criteria

- Patients with thyroid swellings who underwent FNAC followed by surgical excision (lobectomy/thyroidectomy).
- Availability of both cytology smears and histopathology slides.
- Adequate cytological samples classified according to Bethesda System (I-VI).

Exclusion Criteria

- Cases with inadequate or non-diagnostic FNAC samples (Bethesda I) without subsequent repeat sampling.
- Cases lacking histopathological correlation or incomplete records.
- Patients who received neoadjuvant therapy before surgery.

Procedure and Methodology

FNAC was performed under aseptic precautions using a 23-25 gauge needle attached to a 10 mL syringe. Both aspiration and non-aspiration techniques were used based on nodule characteristics. For deep-seated or cystic lesions, ultrasound-guided FNAC was performed to ensure representative sampling. Multiple passes were made when necessary to obtain adequate material.

Smears were immediately fixed in 95% ethanol for Papanicolaou and Hematoxylin & Eosin (H&E) staining, while air-dried smears were stained with Giemsa. Each FNAC case was categorized according to the Bethesda System for Reporting Thyroid Cytopathology (TBSRTC, 2017) into six categories (I-VI). The cytological diagnosis was later correlated with the final histopathological diagnosis obtained from the surgical specimen.

Sample Processing

Surgically excised thyroid specimens were fixed in 10% buffered formalin, grossed according to standard protocols, and representative sections were taken. Paraffin-embedded tissue sections of 4-5 µm thickness were stained with H&E. Histopathological diagnoses were classified as benign (e.g., multinodular goiter, follicular adenoma, thyroiditis) or malignant (e.g., papillary carcinoma, follicular carcinoma, medullary carcinoma).

Data Collection

Clinical data such as age, gender, and type of lesion were retrieved from patient records. FNAC and HPE findings were entered in a structured proforma and classified according to Bethesda categories and corresponding histopathological results.

Statistical Methods

All data were compiled and analyzed using SPSS version 26.0 (IBM Corp., USA). Descriptive statistics were expressed as mean ± standard deviation (SD) for continuous variables and as frequencies or percentages for categorical variables. Diagnostic accuracy parameters-sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy-were calculated using standard 2×2 contingency tables.

The Chi-square test or Fisher's exact test was applied for assessing association between categorical variables. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Diagnostic performance overview (FNAC vs HPE; binary: "malignant" = Bethesda VI)

Metric / Breakdown	n (%) or Mean (SD)	Test of significance	Effect size / 95% CI	p-value
FNAC "malignant" (Bethesda VI)	3/88 (3.4%)	-	Proportion 0.034 (0.012-0.095)*	-
HPE malignant (reference)	12/88 (13.6%)	-	Proportion 0.136 (0.079-0.225)*	-
Confusion matrix (FNAC VI vs HPE)	TP=3, FP=0, FN=9, TN=76	Fisher's exact (2×2)	OR not estimable (FP=0)	0.0020
Overall accuracy	79/88 (89.8%)	Exact binomial	0.898 (0.817-0.945)	-
Agreement (Cohen's κ)	0.37	-	95% CI −0.03 to 0.76 (approx.)	-

Exact/Wilson 95% CIs shown for proportions.

Table 1 summarizes the overall diagnostic performance of Fine Needle Aspiration Cytology (FNAC) when compared with the histopathological examination (HPE) as the reference standard. Out of 88 patients, only three cases (3.4%) were diagnosed as malignant cytologically (Bethesda VI), whereas 12 cases (13.6%) were histologically confirmed as malignant. The confusion matrix demonstrated 3 true positives, 0 false positives, 9 false negatives, and 76 true negatives. Fisher's exact test revealed a statistically significant correlation between cytology and histopathology ($p = 0.002$), confirming a non-random association between the two diagnostic methods. The overall diagnostic accuracy was 89.8%, with a 95% confidence interval (CI) ranging from 0.817 to 0.945, indicating good agreement between FNAC and HPE. Cohen's κ value of 0.37 reflected fair inter-method agreement, implying that while FNAC correctly identified most benign cases, a subset of malignant lesions was missed, highlighting the need for clinicoradiological correlation and possible repeat sampling in suspicious cases.

Table 2: Cytology-histology correlation by Bethesda category

FNAC category (TBSRTC)	Total (n)	HPE benign n (%)	HPE malignant n (%)	Category vs HPE association
I - Non-diagnostic/Unsatisfactory	5	5 (100.0)	0 (0.0)	
II - Benign	73	67 (91.8)	6 (8.2)	
IV - Follicular neoplasm / SFN	7	4 (57.1)	3 (42.9)	
VI - Malignant	3	0 (0.0)	3 (100.0)	
Total	**88**	**76 (86.4)**	**12 (13.6)**	**$\chi^2(3)=26.68$; Cramer's V=0.55; p<0.001**

Table 2 presents the detailed cytology-histology correlation according to the Bethesda System for Reporting Thyroid Cytopathology (TBSRTC). Of the total 88 cases, five were non-diagnostic (Category I), 73 benign (Category II), seven follicular neoplasm/suspicious for follicular neoplasm (Category IV), and three malignant (Category VI). Histopathological examination confirmed malignancy in 6 cases (8.2%) of Category II, 3 cases (42.9%) of Category IV, and all 3 cases (100%) of Category VI. The chi-square association between Bethesda category and histopathological outcome was highly significant ($\chi^2 = 26.68$, $p < 0.001$) with a Cramer's V of 0.55, indicating a strong association. These results demonstrate the progressive increase in malignancy risk with higher Bethesda categories, reaffirming the validity of the Bethesda stratification. Category II remained largely benign, whereas Category IV showed an intermediate but clinically important risk, emphasizing its grey-zone nature that warrants diagnostic lobectomy. Category VI maintained perfect concordance with histopathology, confirming its predictive value for malignancy.

Table 3: Diagnostic accuracy of FNAC for thyroid malignancy (positive test = Bethesda VI)

Parameter	Estimate	95% CI	Method / Notes	p-value
Sensitivity	25.0%	8.9-53.2%	TP/(TP+FN)=3/12	-
Specificity	100.0%	95.2-100.0%	TN/(TN+FP)=76/76	-
PPV	100.0%	43.8-100.0%	3/3	-
NPV	89.4%	81.1-94.3%	76/85	-
Accuracy	89.8%	81.7-94.5%	(TP+TN)/N	-
Likelihood ratio (+)	**Not estimable**	-	Division by (1-specificity)=0	-
LR(+) with Haldane-Anscombe	41.46	-	0.5 added to each cell	-
LR(−) with Haldane-Anscombe	0.736	-	0.5 added to each cell	-
FNAC (VI) vs HPE malignancy	-	-	Fisher's exact (2×2)	**0.0020**

All CIs are Wilson/normal-approx. as appropriate. The "no FP" structure yields perfect specificity and PPV, hence LR(+) requires continuity correction.

Table 3 highlights the diagnostic accuracy indices for FNAC when malignancy is defined as Bethesda VI. The test showed a sensitivity of 25% (95% CI = 8.9-53.2%), reflecting its limited ability to detect all malignant cases, whereas specificity and positive predictive value (PPV) reached 100% (95% CI = 95.2-100%), confirming the high reliability of a cytological diagnosis of malignancy. The negative predictive value (NPV) was 89.4% (95% CI = 81.1-94.3%), implying that benign FNAC results were accurate in nearly nine out of ten cases. Overall accuracy was 89.8%, similar to the figure derived in Table 1. Fisher's exact test again showed statistical significance ($p = 0.002$). Because no false positives occurred, the positive likelihood ratio was not directly calculable; continuity correction estimated it as 41.46, reinforcing that a positive cytological diagnosis (Bethesda VI) substantially increases the probability of malignancy. The moderate negative likelihood ratio (0.736) signifies that a negative cytology does not completely exclude malignancy, underscoring the importance of histopathological confirmation for indeterminate or suspicious nodules.

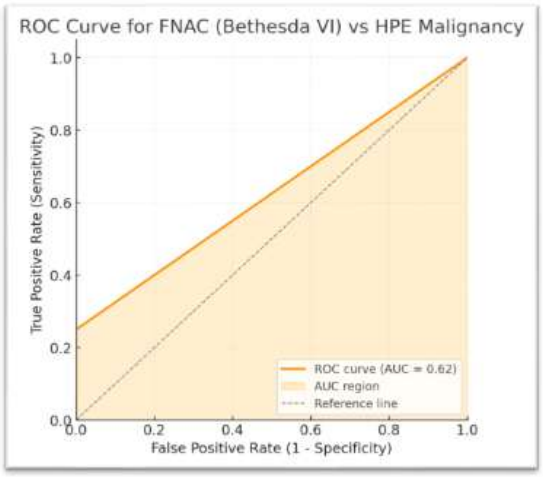

Figure : ROC curve with AUC

Table 4: Distribution and malignancy risk by Bethesda category

Bethesda category	n	Malignant n (%)	95% CI for risk	Risk ratio vs Bethesda II	95% CI (RR)	Test (vs II)
I -Non-diagnostic	5	0 (0.0)	-	-	-	-
II - Benign	73	6 (8.2)	3.8-16.8%	Reference	-	-
IV - Follicular neoplasm / SFN	7	3 (42.9)	15.8-74.95%	**5.21**	1.65-16.45	Fisher exact p=0.010
VI - Malignant	3	3 (100.0)	43.85-100.0%	**9.96**†	4.38-22.67	Fisher exact p=0.001

Table 4 delineates the distribution of malignancy risk across Bethesda categories. The overall malignancy rate in the study was 13.6%. Risk of malignancy increased markedly from Category II (8.2%, 95% CI 3.8-16.8%) to Category IV (42.9%, 95% CI 15.8-74.9%) and reached 100% (95% CI 43.9-100%) in Category VI. Compared with Bethesda II as the reference, the relative risk (RR) of malignancy was 5.21 (95% CI 1.65-16.45, $p = 0.010$) for Category IV and 9.96 (95% CI 4.38-22.67, $p = 0.001$) for Category VI, both statistically significant. This stepwise escalation in malignancy

risk corroborates the predictive utility of the Bethesda classification in guiding clinical management. Category IV lesions, despite cytological ambiguity, demonstrated a considerable malignancy rate justifying surgical excision, whereas Category VI lesions showed definitive malignant potential warranting total thyroidectomy.

Table 5: Correlation between FNAC Diagnosis and Histopathology Diagnosis (N = 88)

FNAC Diagnosis	number	Colloid cyst	Colloid Goiter	Nodular goitre	Adenomatoid goitre	Hurthle Cell Adenoma	Hashimoto Thyroiditis	Follicular adenoma	NIFTP	FVPC	Papillary carcinoma	Thyroglossal cyst
Non-Diagnostic	5	3	2									
Colloid cyst	2		2									
Colloid goitre	24		13	3	6						2	
Nodular goitre	22		0	12	4			2	1	2	1	
Adenomatoid goitre	10		0	1	7				1	1		
Hashimoto thyroiditis	6			1			5					
Thyroglossal cyst	6										2	4
Hyperplastic nodule	2								1		1	
Hurthle cell adenoma	1					1						
Follicular Neoplasm	7			1	1			2		3		
Papillary carcinoma	3										3	
Medullary ca	0											
Sq cell ca	0											
Total	88	3	17	18	18	1	5	4	3	6	9	4

Table 5 presents the correlation between Fine Needle Aspiration Cytology (FNAC) findings and corresponding histopathological diagnoses in 88 thyroid specimens. The most frequent histopathological diagnosis was Nodular goiter as well as Ademateoid goiter observed in 18 cases (20.4%) each, followed by colloid goitre in 17 cases (19.2%), follicular variant of papillary carcinoma found in 6 cases (6.8%), papillary carcinoma in 9 cases (10.2%).

Out of 24 cases of colloid goitre diagnosed by FNAC 13 cases were histopathologically proven to be colloid goiter,6 cases were adenomatid goiter and 1 case were diagnosed as papillary carcinoma and 1 as Microcpapillary carcinoma. On reviewing the cytology slides, of papillary carcinoma there were seen focal areas of dilated papillae filled with colloid and probably the aspiration needle has not hit that site. This can be avoided by aspirating from multiple sites. Case of occult micro papillary carcinoma was an incidental finding on histology and is one of the limitations of fine needle aspiration cytology. The term occult papillary carcinoma is used for tumours smaller than 1.5 cms in diameter and nowadays it is preferred for tumours with no clinical signs. In our study, one patient was a 31 -year-old male who presented clinically as suprasternal cyst and enlarged pre and paratracheal lymph nodes. Lymph nodes were positive for metastasis of papillary carcinoma on histopathology.

Out of 22 cases of nodular goitre diagnosed by FNAC, 12 cases were histopathologically proven to be nodular goiter,4 adenomatoid goiter, and 2 cases were diagnosed as (FVPC) Follicular variant of papillary carcinoma and 1 case turned out to be papillary carcinoma with coexisting Nodular goiter. Two cases of FVPC were missed on cytology due to the presence of thick colloid and hemorrhage in which cells were trapped. Hence, there was masking of repetitive follicles. One case of papillary carcinoma with NG was missed on cytology. On reviewing the cytology slides there were mainly follicular cells in sheets and in singles with many cystmacrophages in the background (Figure 3).

There were no cytological features consistent with papillary carcinoma in the slides reviewed. Probably the aspiration needle has hit the NG dominant nodule of thyroid gland but the nodule was showing cytological features of NG, cystic areas with papillary excrescences were not hit by our needle.
Out of 10 cases diagnosed as adenomatoid goitre by FNAC, 7cases histopathologically were consistent with adenomatoid goiter, 1 case was NIFTP (Non-Invasive follicular tumor with papillary like nuclear features) and 1 case turned out to be Follicular variant of papillary carcinoma. Discordance in this case was mainly due to hemorrhage on cytology smears which are masking the repetitive follicles.

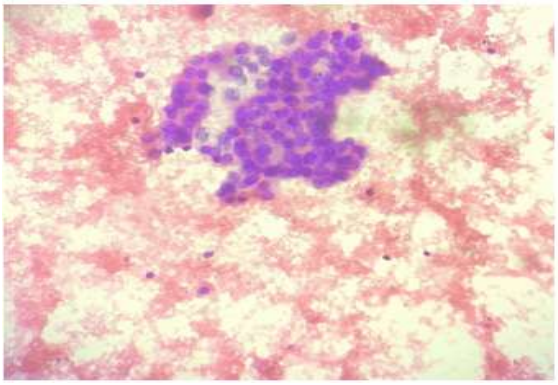

Figure 1: Photomicrograph of Papillary carcinoma showing highlycellular smears with cellsarranged in branching papillarypattern. FNAC. (Pap. 10X)

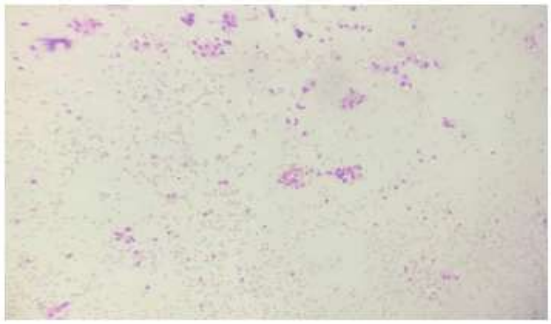

Figure 2: Photomicrograph of follicular neoplasm showing cellular smears with cells arranged in repetitive follicular pattern. FNAC. (Pap. 10X)

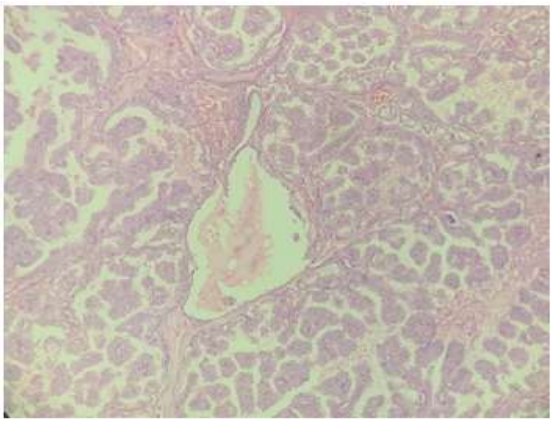

Figure 3: Photomicrograph of Papillary carcinoma showing papillaewith fibrovascular core. (H&E-10X)

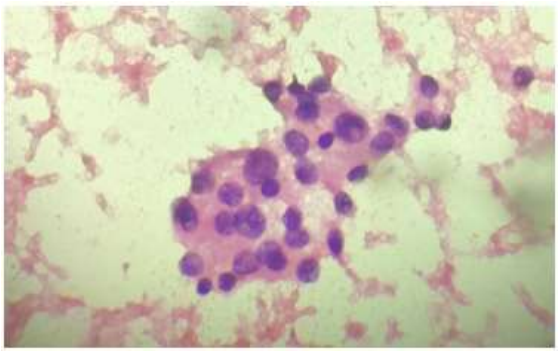

Figure 4: Photomicrograph of Papillary carcinoma showingIntranuclear cytoplasmic inclusions (INCIs) FNAC. (Pap. 10X)

DISCUSSION

Table 1 (overall performance; binary "malignant" = Bethesda VI): binary framing-counting only Bethesda VI as a "positive" cytology-naturally yields very high specificity/PPV (both 100%) and lower sensitivity (driven by FN cases sitting in II/IV). This pattern is consistent with TBSRTC guidance and multiple series showing that unequivocally malignant cytology has near-perfect rule-in capacity, while misses often stem from sampling error, cystic/follicular architecture, or dual pathology (benign nodule harboring microcarcinoma). Cibas& Ali emphasize exactly this trade-off: specificity is typically ≥95-100% for malignant calls, whereas sensitivity depends on whether "suspicious" (V) and "follicular neoplasm" (IV) are counted as test-positive or not Reddy BSet al.(2023).[6] Meta-analyses that treat V+VI as positive report higher sensitivities (=80-90%) with preserved high specificity (=92-98%),[3] by contrast, VI-only definition understandably lowers sensitivity (25%) while preserving accuracy (=90%). The significant Fisher's test (p=0.002) and κ=0.37 (fair agreement) are consistent with single-center datasets where malignant prevalence is low and indeterminate buckets are sizable Osseis Met al.(2023),[7] & Silva RR et al.(2023).[8]

Table 2 (cytology-histology by Bethesda category): The step-up in malignancy from II → IV → VI (8.2% → 42.9% → 100%) mirrors TBSRTC risk stratification trends, though Category II ROM (8.2%) is higher than the TBSRTC 2017 benchmarks (=0-3% in many series) and the pooled estimates from Jain Det al.(2023),[9] (=3.7% for II).[2,3] Elevated ROM in II has been reported in institutional cohorts with a higher background prevalence of cancer, selective surgery of "benign" nodules, or cytologic under-calling in Hashimoto/cystic PTCs. Category IV ROM (42.9%) sits at the upper end of published ranges (often 15-30%, extending to 40-45% in some surgical-enriched series), aligning with the known "grey-zone" biology where capsular/vascular invasion cannot be assessed on cytology.[2,3,6] Perfect concordance in Category VI (100%) is textbook and

reinforces FNAC's strong rule-in value [1-3]. The strong association (χ^2=26.68; Cramer's V=0.55; p<0.001) is what high-quality TBSRTC implementation typically shows. Khan AAet al.(2025).[10]

Table 3 (diagnostic accuracy indices; positive = VI): With no false positives, specificity and PPV of 100% replicate the classic strength of cytology when labeled "malignant". The sensitivity of 25% reflects (i) strict positivity definition (excluding V and IV), (ii) nine false-negative cancers-fully compatible with literature citing geographic miss, cystic change, follicular-patterned cancers, and coexisting lesions as the main mechanisms Jambhulkar Met al.(2022).[11] The NPV =89% is typical for cohorts with modest malignancy prevalence (14%). Because 1-specificity=0, the LR(+) is not estimable without continuity correction; the corrected LR(+) =41 indicates that a VI call massively shifts post-test probability-again, in line with pooled analyses Alhajlan Met al.(2024)[12]. The significant Fisher's p=0.002 confirms that VI calls are meaningfully associated with malignant HPE even in a small sample.

Table 4 (distribution & risk by Bethesda category): risk gradient produces RR=5.2 for IV vs II and RR=10 for VI vs II, both statistically significant, which echoes pooled estimates wherein ROM escalates stepwise across categories and supports guideline-concordant management: surveillance for II (with clinical/US triggers for repeat FNAC), diagnostic surgery for IV, and definitive surgery for VI Dabhi Det al.(2025).[13] The higher-than-benchmark ROM for II in series suggests either selection bias (only operated "benigns" included), center-specific case mix, or interpretative thresholds-all well-described reasons for inter-study ROM variability. Clinically, data underscore two practical points from guidelines: (1) do not over-reassure on a single "benign" result in discordant clinical/sonographic contexts; (2) treat IV seriously, as ROM sits at the high end of published ranges Gąsiorowski Oet al.(2024).[14]

Table 5. Cyto-Histological Correlation of 88 Cases: Out of 7 cases of follicular neoplasm diagnosed by FNAC, 2 cases histopathologically were follicular adenoma and 3 cases turned out to be Follicular variant of papillary carcinoma. Hall TL et al. intheir study of 17 cases of follicular neoplasm on FNAC, 10 cases were confirmed on histopathology with a diagnostic accuracy of 58.8%. This less diagnostic accuracy is explained by the fact that, there always exist confusion between hyperplastic nodular goitre and follicularadenoma. This error is generally accepted as unavoidable because of cytomorphologic similarity and the need to maintain a high degree of sensitivity to the presence of a neoplastic process requiring surgical biopsy. Hall T(1989),[15] All 3 cases of papillary carcinoma diagnosed by FNAC, were histopathologically confirmed to be papillary carcinoma.

CONCLUSION

The present study demonstrated a strong correlation between Fine Needle Aspiration Cytology (FNAC) and histopathological examination (HPE) in thyroid lesions when classified according to the Bethesda System for Reporting Thyroid Cytopathology (TBSRTC). Among 88 evaluated cases, FNAC exhibited a high overall diagnostic accuracy of 89.8%, with specificity and positive predictive value (PPV) of 100%, confirming its reliability as a first-line diagnostic tool. Although sensitivity (25%) was modest-primarily due to false negatives resulting from sampling errors and overlapping cytological features-FNAC accurately differentiated benign from malignant lesions in the majority of cases. The risk of malignancy increased progressively from Bethesda II (8.2%) to IV (42.9%) and VI (100%), reinforcing the Bethesda classification's predictive value and clinical utility. Hence, FNAC, when interpreted alongside clinical and radiological findings, remains an indispensable, minimally invasive, and cost-effective diagnostic method for preoperative evaluation of thyroid nodules. Routine cytology-histology correlation further enhances diagnostic precision and guides optimal management strategies.

Limitations of The Study

1. **Retrospective Design:** The retrospective nature limited control over sampling and documentation, possibly introducing selection bias.
2. **Sample Size:** The relatively small cohort (n=88) may restrict the generalizability of statistical estimates, especially within higher Bethesda categories (IV and VI).
3. **Lack of Bethesda III and V Categories:** Absence of indeterminate (AUS/FLUS and Suspicious for Malignancy) categories restricted full assessment of TBSRTC spectrum.
4. **Operator and Interpretive Variability:** FNAC outcomes may have been influenced by individual technique and observer interpretation, which were not standardized.
5. **Limited Ancillary Testing:** Immunocytochemistry or molecular studies were not utilized, which could have improved the detection of indeterminate and follicular-patterned lesions.
6. **Sampling Error:** False-negative results due to inadequate or non-representative sampling could not be entirely excluded despite re-evaluation.

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