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Original Research Article

Comparative Study of the Accuracy of Preoperative Investigations Such as USG and FNAC with Postoperative Histopathological Findings in Diagnosing the Spectrum of Thyroid Disorders at a Tertiary Care Centre in Idukki

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Abstract:

Introduction: The thyroid gland is the first endocrine gland to develop in the human embryo, beginning its formation by the third week of gestation as a thickening in the floor of the primitive pharynx between the first and second pharyngeal pouches. This thickening gives rise to a diverticulum that migrates caudally in front of the pharyngeal gut while remaining temporarily connected to the tongue by the thyroglossal duct.

Aims: To compare the diagnostic accuracy of sonography, fine needle aspiration cytology (FNAC), and histopathological examination in evaluating thyroid disorders. To assess the correlation of clinical, radiological, and cytological findings with final histopathological outcomes in patients with thyroid swellings.

Materials & Methods: The present study was a prospective observational study. This Study was conducted from 1 year at Department General Surgery, Al Azhar Medical College & Super Speciality Hospital,Total 107 patients were included in this study.

Result: In our study of 107 patients, the majority (74 patients, 69.2%) had no comorbidities. Among those with comorbidities, diabetes mellitus (DM) was the most common, seen in 8 patients (7.5%), followed by hypertension (HTN) in 7 patients (6.5%). Some patients had combinations of conditions such as DM with HTN, COPD, or DLP. The statistical analysis showed a highly significant ($P < 0.00001$). In our study of 107 patients, the majority were euthyroid (74 patients, 69.2%), meaning they had normal thyroid function. Hyperthyroidism was found in 21 patients (19.6%), hypothyroidism in 12 patients (11.2%). The P value was < 0.00001, indicating a statistically significant.

Conclusion: We concluded that the study carried out at a tertiary care facility in Idukki revealed a predominance of benign cytology (Bethesda II) and euthyroid status among patients. A considerable number were diagnosed with multinodular goitre, and some also had coexisting hypertension and diabetes mellitus.

Keywords: Sonography, FNAC, Euthyroid, Thyroid and Bethesda system.

Introduction

The thyroid gland is the first endocrine gland to develop in the human embryo, beginning its formation by the third week of gestation as a thickening in the floor of the primitive pharynx between the first and second pharyngeal pouches. This thickening gives rise to a diverticulum that migrates caudally in front of the pharyngeal gut while remaining temporarily connected to the tongue by the thyroglossal duct [1].Anatomically, the thyroid gland is located anteriorly in the neck, below the larynx and above the trachea. It consists of two lobes joined by an isthmus, giving it a butterfly shape. The gland receives arterial blood from the superior thyroid artery, a branch of the external carotid artery, and the inferior thyroid artery, a branch of the thyrocervical trunk. Venous drainage occurs via the superior and middle thyroid veins (draining into the internal jugular vein) and the

inferior thyroid vein (draining into the brachiocephalic vein) [2]. Lymphatic drainage is extensive and includes the Delphian, pretracheal, perithyroidal, and lateral cervical lymph nodes. Nerve supply includes sympathetic fibers from the superior, middle, and inferior cervical ganglia, and parasympathetic innervation from the recurrent and superior laryngeal branches of the vagusnerve [3]. Microscopically, the thyroid consists of follicles (~200 µm diameter) filled with colloid, composed of thyroglobulin and thyroid hormones. The follicles are lined by cuboidal epithelial cells, while parafollicular cells (C cells), mainly in the upper lobes, secrete calcitonin, a hormone regulating calcium metabolism [4].Thyroid nodules are commonly evaluated using ultrasound (USG). Suspicious USG findings include microcalcifications, increased vascularity, capsular invasion, and lymphadenopathy, which may indicate malignancy [5]. To standardize interpretation, the ACR-TIRADS (Thyroid Imaging Reporting and Data System) classifies nodules based on USG features and provides scoring criteria to guide further management—either follow-up or fine needle aspiration cytology (FNAC) [6].FNAC is a minimally invasive and widely used technique for preoperative evaluation of thyroid nodules. It is highly sensitive and specific for diagnosing papillary thyroid carcinoma (PTC) but cannot distinguish between follicular adenoma and follicular carcinoma, as the latter requires histopathological evidence of capsular or vascular invasion [7]. The Bethesda System for Reporting Thyroid Cytopathology helps standardize FNAC results and determine malignancy risk [8].Histologically, benign nodules such as adenomatous nodules show variable follicular architecture and usually lack a capsule. In contrast, follicular adenomas are encapsulated, with uniform follicles. Oncocytic cells (Hurthle cells) have eosinophilic granular cytoplasm and abundant mitochondria. Sanderson's polsters, small follicles within large ones, can mimic papillary structures but lack malignant nuclear features [4].

Thyroid malignancies include papillary carcinoma, characterized by nuclear clearing, grooves, and inclusions; follicular carcinoma, which shows capsular/vascular invasion; medullary carcinoma, derived from C cells and positive for calcitonin and CEA; and anaplastic carcinoma, an undifferentiated and aggressive tumor [1,4,9]. While solitary nodules are more suspicious than multiple nodules, no single test reliably differentiates benign from malignant nodules, emphasizing the importance of multimodal evaluation [5,6].

Materials and Methods

Study Design

A prospective observational study

Place of study

Department of General Surgery, Al Azhar Medical College & Super Speciality Hospital.

Period of study

1 year 1st May 2024 to 1st May 2025.

Sample Size

107 patients presenting with thyroid swellings

Inclusion Criteria

- Patients aged 18 years and above presenting with thyroid swellings.
- Patients who underwent thyroid ultrasonography (TIRADS classification).
- Patients who underwent fine needle aspiration cytology (FNAC) with Bethesda reporting.

Exclusion Criteria

- Patients below 18 years of age.
- Patients with previously diagnosed thyroid malignancy.
- Patients who did not undergo all three diagnostic modalities (USG, FNAC, and histopathology).
- Patients with incomplete medical records or lost to follow-up.

Study Variables

- Age
- Gender
- Presence of thyroid swelling
- Comorbidities (e.g., diabetes mellitus, hypertension)
- Ultrasonographic features (TIRADS classification)
- Number and size of nodules

The Bethesda System is a standardized reporting framework for thyroid fine needle aspiration cytology (FNAC). It categorizes thyroid lesions into six diagnostic groups, each associated with an estimated risk of malignancy and recommended clinical management. These categories range from I: Non-diagnostic, II: Benign, III: Atypia of Undetermined Significance (AUS)/Follicular Lesion of Undetermined Significance (FLUS), IV: Follicular Neoplasm/Suspicious for Follicular Neoplasm, V: Suspicious for Malignancy, to VI: Malignant. The Bethesda system enhances communication between pathologists and clinicians and guides appropriate patient management decisions. The TIRADS scoring system is a standardized ultrasound-based classification used to assess the risk of malignancy in thyroid nodules. It evaluates features such as composition, echogenicity, shape, margin, and presence of echogenic foci. Based on these characteristics, nodules are categorized from TIRADS 1 (benign) to TIRADS 5 (highly suspicious of malignancy). This system aids radiologists and clinicians in risk stratification and in making decisions about the

need for fine needle aspiration or follow-up imaging.

Statistical Analysis

For statistical analysis, data were initially entered into a Microsoft Excel spreadsheet and then analyzed using SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and GraphPad Prism (version 5). Numerical variables were summarized using means and standard deviations, while Data were entered into Excel and analyzed using SPSS and GraphPad Prism.

Numerical variables were summarized using means and standard deviations, while categorical variables were described with counts and percentages. Two-sample t-tests were used to compare independent groups, while paired t-tests accounted for correlations in paired data. Chi-square tests (including Fisher's exact test for small sample sizes) were used for categorical data comparisons. P-values ≤ 0.05 were considered statistically significant.

Result

Table 1: Distribution of Comorbidities

Comorbidities	Frequency	Percent	P value
DM	8	7.5	<.00001
DM, HTN	9	8.4	
DM, COPD	1	0.9	
DM, DLP, CAD	2	1.9	
HTN	7	6.5	
HTN, DLP	1	0.9	
HTN, DM, COVID	1	0.9	
HTN, DM, DLP	1	0.9	
HTN, COPD, DLP	1	0.9	
HTN, DLP, GERD	1	0.9	
Hyperthyroidism	1	0.9	
None	74	69.2	
Total	107	100	

Table 2: Distribution of Thyroid Status

Thyroid Status	Frequency	Percent	P value
Euthyroid	74	69.2	< .00001
Hyperthyroid	21	19.6	
Hypothyroid	12	11.2	
Total	107	100.0	

Table 3: Distribution of USG

USG	Frequency	Percent	P value
MNG	41	38.3	
TIRADS I	9	8.4	
TIRADS II	11	10.3	
TIRADS III	19	17.8	< .00001
TIRADS IV	24	22.4	
TIRADS V	3	2.8	
Total	107	100.0	

Table 4: Distribution of FNAC

FNAC	Frequency	Percent	P value
Bethesda II	64	59.8	
Bethesda III	11	10.3	
Bethesda IV	23	21.5	< .00001
MNG	9	8.4	
Total	107	100.0	

Table 5: Comparison of Preoperative Diagnostic Modalities (USG and FNAC) with Final Histopathological Examination (HPE) in Detecting Thyroid Carcinoma

		Frequency	Percent	P-values
USG Group	Carcinoma	46	43	0.04036
	Benign	61	57	
	Total	107	100	
FNAC Group	Carcinoma	34	31.8	<0.00001
	Benign	73	68.2	
	Total	107	100	
HPE final diagnosis	Carcinoma	35	32.7	<0.00001
	Benign	72	67.3	
	Total	107	100	

Table 6: USG Group vs. HPE final diagnosis

Crosstab					
			HPE final diagnosis		Total
			Carcinoma	Benign	
USG Group	Carcinoma	Count	25	21	46
		% within USG Group	54.30%	45.70%	100.00%
		% within HPE final diagnosis	71.40%	29.20%	43.00%
	Benign	Count	10	51	61
		% within USG Group	16.40%	83.60%	100.00%
		% within HPE final diagnosis	28.60%	70.80%	57.00%
Total		Count	35	72	107
		% within USG Group	32.70%	67.30%	100.00%
		% within HPE final diagnosis	100.00%	100.00%	100.00%

Sensitivity: 71.4%
Specificity: 70.8%
Positive Predictive Value (PPV): 54.3%
Negative Predictive Value (NPV): 83.6%
Accuracy: 71.0%

Table 7: FNAC Group vs. HPE final diagnosis

Crosstab					
			HPE final diagnosis		Total
			Carcinoma	Benign	
FNAC Group	Carcinoma	Count	32	2	34
		% within FNAC Group	94.10%	5.90%	100.00%
		% within HPE final diagnosis	91.40%	2.80%	31.80%
	Benign	Count	3	70	73
		% within FNAC Group	4.10%	95.90%	100.00%
		% within HPE final diagnosis	8.60%	97.20%	68.20%
Total		Count	35	72	107
		% within FNAC Group	32.70%	67.30%	100.00%
		% within HPE final diagnosis	100.00%	100.00%	100.00%

Sensitivity: 91.4%
Specificity: 97.2%
Positive Predictive Value (PPV): 94.1%
Negative Predictive Value (NPV): 95.9%
Accuracy: 95.3%

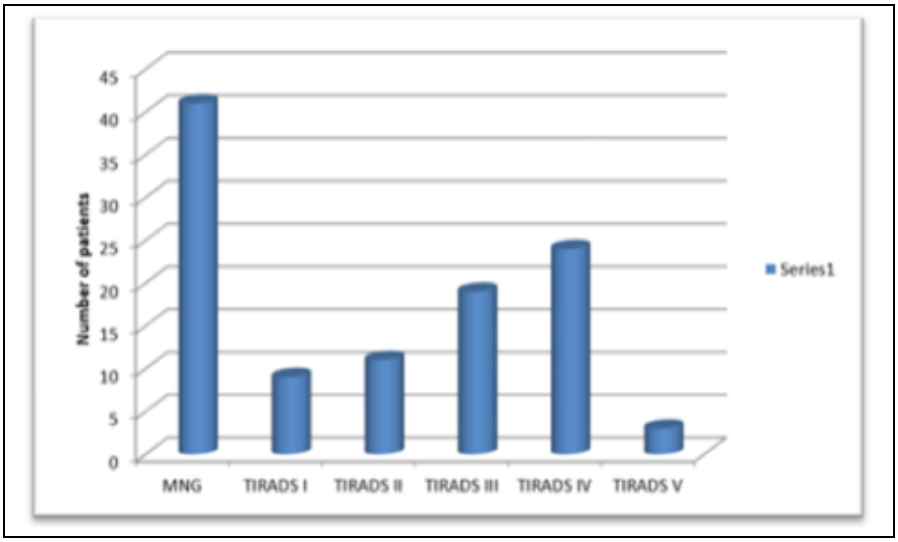

Figure 1: Distribution of USG

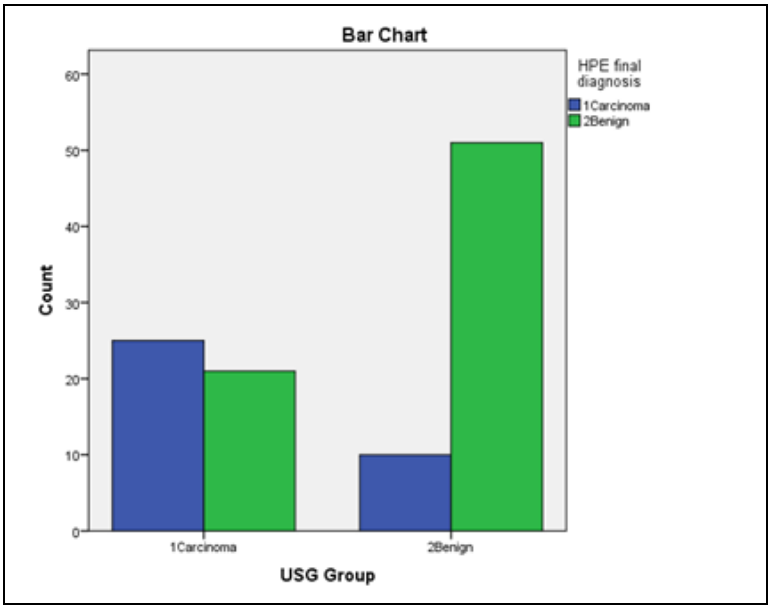

Figure: 2. Comparison of USG Groups with HPE Final Diagnosis

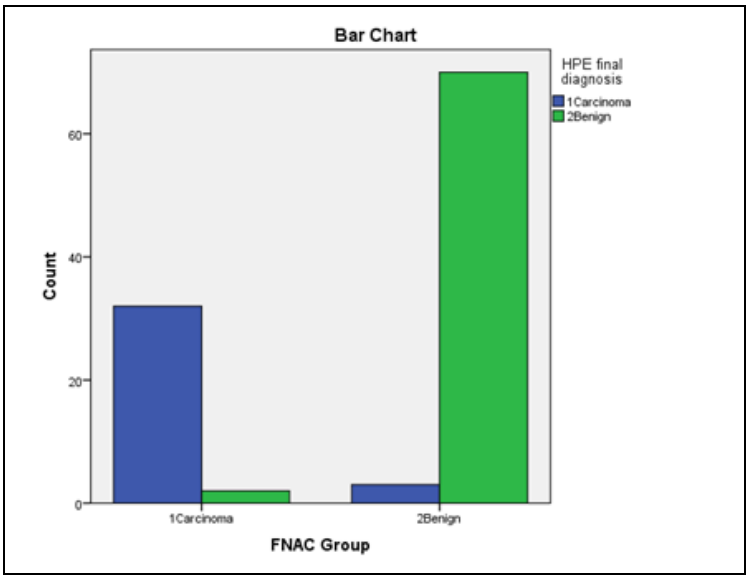

Figure: 3. Comparison of FNAC Groups with HPE Final Diagnosis

In our study of 107 patients, the majority (74 patients, 69.2%) had no comorbidities. Among those with comorbidities, diabetes mellitus (DM) was the most common, seen in 8 patients (7.5%), followed by hypertension (HTN) in 7 patients (6.5%). Some patients had combinations of conditions such as DM with HTN, COPD, or DLP. The statistical analysis showed a highly significant ($P < 0.00001$). In our study of 107 patients, the majority were euthyroid (74 patients, 69.2%), meaning they had normal thyroid function. Hyperthyroidism was found in 21 patients (19.6%), hypothyroidism in 12 patients (11.2%). The P value was < 0.00001, indicating a statistically significant. In our study, out of the total population, 41 patients (38.3%) were diagnosed with multinodular goitre (MNG). When categorized according to the TIRADS (Thyroid Imaging Reporting and Data System) classification, 9 patients (8.4%) were TIRADS I, 11 patients (10.3%) were TIRADS II, 19 patients (17.8%) were TIRADS III, 24 patients (22.4%) were TIRADS IV, and 3 patients (2.8%) were TIRADS V. it is statistically significant ($P < 0.00001$). In our study, the majority of patients were classified as Bethesda II (benign), comprising 64 patients (59.8%). This was followed by Bethesda IV (suspicious for follicular neoplasm) with 23 patients (21.5%) and Bethesda III (atypia of undetermined significance) with 11 patients (10.3%). A smaller portion of patients—9 patients (8.4%)—were diagnosed with multinodular goitre (MNG) cytologically. The P value was < 0.00001 statistically significant.

Among the 107 patients, ultrasonography (USG) classified 46 cases as carcinoma and 61 as benign. Of the 46 cases labelled carcinoma by USG, 25 (54.3%) were confirmed as carcinoma on histopathological examination (HPE), while 21 (45.7%) were benign. Conversely, among the 61 cases labeled benign by USG, 51 (83.6%) were indeed benign on HPE, and 10 (16.4%) were found to be carcinoma. Within the total 35 histopathologically confirmed carcinoma cases, 71.4% were correctly identified as carcinoma by USG, whereas 28.6% were misclassified as benign. Similarly, among the 72 histopathologically benign cases, 70.8% were correctly identified by USG, and 29.2% were misclassified as carcinoma. Of the 107 patients, fine-needle aspiration cytology (FNAC) categorized 34 cases as carcinoma and 73 as benign. Among the 34 FNAC-diagnosed carcinoma cases, 32 (94.1%) were confirmed as carcinoma on histopathological examination (HPE), while only 2 (5.9%) were false positives. Among the 73 cases labeled benign by FNAC, 70 (95.9%) were confirmed benign, and 3 (4.1%) were actually carcinoma. Out of the total 35 histopathologically confirmed carcinoma cases, FNAC correctly identified 91.4%, whereas 8.6% were misclassified as benign. Of the 72 benign cases, FNAC accurately diagnosed 97.2% and misclassified only 2.8% as carcinoma.

Discussion

In similar study by Yue WS et al [10] (2011) found that out of the total cohort, a significant proportion of patients with diabetes mellitus (n = 30, 28.0%) and Jabri MA et al [11] (2017) found that out of the total study population, 21 patients (19.6%) were hypertensive. We found that 9 patients (8.4%) had both diabetes mellitus (DM) and hypertension (HTN). The association was found to be statistically significant ($P < 0.00001$).

In similar study by Schoelwer MJ et al [12] (2015) observed that the total participants, 74 patients (69.2%) were found to be euthyroid. We found that the majority of patients had euthyroid, accounting for 74 patients (69.2%). This distribution was observed to be statistically significant ($P < 0.00001$).

In others study by Kamran SC et al [13](2013) observed that the total study population, 41 patients (38.3%) had multinodular goitre.We found that 41 patients (38.3%) had diagnosed with multinodular goitre (MNG). This distribution was found to be statistically significant ($P < 0.00001$). In others study by Cibas ES et al [14] (2017) observed that the total cohort, 64 patients (59.8%) were reported as Bethesda II (benign).We found that the majority of patients had categorized as Bethesda II, indicating benign cytology, comprising 64 patients (59.8%). This finding was statistically significant ($P < 0.00001$). In our study, fine-needle aspiration cytology (FNAC) demonstrated superior diagnostic accuracy compared to ultrasonography (USG) in differentiating between malignant and benign lesions. FNAC correctly identified 91.4% of histopathologically confirmed carcinoma cases, with a false-negative rate of 8.6%, and showed a high specificity of 97.2%. In contrast, USG had a lower sensitivity of 71.4% and specificity of 70.8%, with a higher rate of false negatives (28.6%) and false positives (29.2%). These findings are consistent with the observations of Kocjan et al. (2013), who reported that FNAC had a high sensitivity (above 90%) and specificity (above 95%) in the preoperative evaluation of head and neck masses, significantly outperforming imaging modalities like USG when used alone [15]. Similarly, a study by Nasuti et al. (2002) emphasized the diagnostic value of FNAC, highlighting its minimal invasiveness and accuracy, especially when guided by imaging, and noted that it remains a cornerstone in the diagnostic pathway for suspicious lesions [16]. These comparative results underscore the reliability of FNAC over USG in initial diagnostic screening and patient triaging.

Conclusion

We concluded that the study carried out at a tertiary care facility in Idukki revealed a predominance of

benign cytology (Bethesda II) and euthyroid status among patients. A considerable number were diagnosed with multinodular goitre, and some also had coexisting hypertension and diabetes mellitus. These findings, all statistically significant, highlight the predominance of benign and euthyroid presentations in thyroid illnesses. In a resource-limited setting, this underscores the importance of integrating sonographic, cytological, and histopathological methods to ensure accurate diagnosis and optimal patient management. FNAC demonstrated higher diagnostic accuracy than USG, with superior sensitivity (91.4% vs. 71.4%) and specificity (97.2% vs. 70.8%) in detecting carcinoma. Thus, FNAC proved to be a more reliable tool for differentiating malignant from benign lesions.

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