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Original Research Article

Diagnostic Accuracy of Ultrasound-Guided FNAC in Thyroid Swellings and its Correlation with Histopathology

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Conflict of interest: Nil

Abstract

Introduction: Thyroid nodules are common endocrine disorders. Although most lesions are benign, early identification of malignancy remains critical. Accurate preoperative diagnosis of thyroid nodules is essential for appropriate surgical decision-making. Ultrasound-guided FNAC is widely used because it is minimally invasive, economical, and highly informative. The present cross sectional study was evaluated the correlation between preoperative FNAC and postoperative histopathological examination (HPE).

Methods: A Cross sectional study was conducted in the Department of General Surgery, at Tertiary Care Hospital, in rural area over 6 months. 90 adult patients with thyroid swelling who underwent ultrasound-guided FNAC followed by surgery were included. Statistical measures including sensitivity, specificity, PPV, NPV, and accuracy were calculated.

Results: Age group 41–50 years constituted the largest subgroup (30%). Females accounted for 85.5%. Solitary thyroid nodules were present in 70%. Benign ultrasound features were seen in 77.8%. Benign cytology was observed in 75.5%, while malignant cytology in 24.4% on FNAC. However, histopathology confirmed 81.1% lesions are benign and 18.8% lesions are malignant. FNAC demonstrated sensitivity of 94.12%, specificity of 91.78%, PPV of 72.73%, NPV of 98.53%, and an overall diagnostic accuracy of 92.22%. Correlation between FNAC and HPE was statistically significant ($p < 0.00001$).

Conclusion: Ultrasound-guided FNAC is a reliable and cost-effective diagnostic tool for thyroid nodules and correlates well with postoperative histopathology. And its Strong cytohistological correlation supports its routine use in surgical practice.

Keywords: Thyroid swelling, FNAC, Histopathology, Thyroid carcinoma, Cytology.

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Introduction

Thyroid nodules represent one of the most common endocrine abnormalities encountered worldwide. Their prevalence has increased significantly with widespread utilization of ultrasonography and cross-sectional imaging [1]. Although most thyroid nodules are benign, the possibility of malignancy remains the primary concern during clinical evaluation. Early and accurate differentiation between benign and malignant lesions is essential to prevent unnecessary surgery while ensuring timely treatment of thyroid cancers.

Fine needle aspiration cytology (FNAC) has become the cornerstone of thyroid nodule assessment because it is simple, inexpensive, minimally invasive, and associated with very low complication rates. FNAC provides valuable cytological information regarding colloid goitre, multinodular goitre, thyroiditis, cystic lesions, and thyroid malignancies. It is particularly effective in diagnosing papillary thyroid carcinoma due to its characteristic nuclear features.

The introduction of ultrasound-guided FNAC has significantly enhanced diagnostic performance [2]. Real-time visualization enables precise needle placement into suspicious regions of thyroid nodules, particularly in small, deep, cystic, calcified, or heterogeneous lesions. Ultrasound guidance improves sample adequacy, reduces sampling error,

and enhances overall diagnostic reliability [1]. Histopathological examination remains the gold standard for final diagnosis because it allows assessment of tissue architecture, capsular invasion, vascular invasion, and tumor differentiation, which cannot be reliably evaluated by cytology alone. Consequently, correlation between FNAC and histopathology serves as the most reliable method for assessing diagnostic performance [3].

The present Cross sectional study was undertaken to evaluate the diagnostic accuracy of ultrasound-guided FNAC in thyroid swellings and correlate preoperative cytological findings with postoperative histopathological examination.

Aims and Objectives

Correlation of USG-guided FNAC findings with the Postoperative histopathological findings.

Patients and Methods

Study Design

A Cross sectional study was conducted to evaluate the correlation between USG-guided FNAC and histopathological examination in thyroid swellings.

Study Period

The study was conducted over 6 months from November 2025 to May 2026.

Study Setting

Study was conducted in the Department of General Surgery in collaboration with the Department of Pathology in a tertiary care hospital.

Study Population

Adult patients presenting with thyroid swelling and planned for surgical management.

Sample Size

Formula:

$$n = \frac{Z^2 \times Se \times (1-Se)}{L^2 \times P}$$

The sample size was calculated using Buderer's formula for diagnostic accuracy studies based on anticipated sensitivity of ultrasound-guided FNAC. Previous studies reported sensitivity ranging from 80% to 90% for the diagnosis of malignant thyroid lesions. Assuming an expected sensitivity of 83%, prevalence of malignancy of 32%, 95% confidence level (Z = 1.96), and absolute precision of 14%, the minimum required sample size was calculated as 86 patients. After accounting for possible exclusions, a final sample size of 90 patients was considered adequate for the study.

Inclusion Criteria: 18 to 80 years of age

Exclusion Criteria

- Thyrotoxicosis
- Haemorrhagic thyroid swelling
- Pregnancy
- Refusal to give consent

Study Procedure

Examination Technique

Both lobes of the thyroid gland, including the isthmus, were evaluated using a Siemens' Acuson machine with a 7.5–12 MHz linear transducer. The patient was positioned supine with the neck hyperextended by placing a pad under the shoulders. The thyroid gland was examined thoroughly due to its superficial location, allowing detailed sonographic visualization of subtle anatomical changes. The neck was scanned in sagittal, transverse, and oblique planes to optimally visualize both thyroid lobes, the isthmus, carotid arteries, and internal jugular veins. Imaging of the lower poles of the thyroid was enhanced by instructing the patient to swallow. The region of carotid arteries and jugular veins laterally and supraclavicular fossa were also examined for any lymphadenopathy.

FNAC Technique

Before FNAC, Neck was positioned in hyperextension, and the skin was cleansed with alcohol-based (Sterillium) solution. A standard 1-inch, 25-gauge, non-cutting bevelled needle attached to a 10 ml syringe was inserted obliquely through the skin in the thyroid region at the front of the neck. The needle was gently but rapidly moved through the center of the thyroid nodule. Gentle suction was applied by pulling the syringe piston. If the specimen was too bloody, aspiration was avoided. In such cases, the 25-gauge needle was inserted into the thyroid gland without suction and moved back and forth to collect the sample.

Capillary action causes the fluid of cells from the nodule to enter the needle, resulting in a less haemorrhagic specimen. Two drops of the aspirate from the syringe were placed on a clean slide. Using a second blank slide held at a 60° angle, the aspirate was spread to form a thin film. This slide-making process was repeated for a second slide, and both slides were then placed in a jar containing absolute alcohol for fixation. Cytopathological examination were carried in Pathology Department from the specimen. After reviewing the USG and FNAC reports, the patient was scheduled for thyroidectomy. The excised sample was sent for histopathological analysis. The USG and FNAC results were then compared with the histopathology findings of the thyroid swelling.

Result

The present Cross sectional study included 90 patients presenting with thyroid swelling who were evaluated and managed in the Tertiary Care Hospital during the study period. The age of the patients ranged from 22 to 64 years, indicating that thyroid swellings were encountered across a wide adult age group. However, the distribution of cases was not uniform across all age categories.

A larger proportion of patients belonged to the third to fifth decades of life, suggesting that thyroid swellings are more frequently identified during the middle adult years. The 41–50 year age group constituted the largest proportion of patients, followed by the 31–40 year group. A smaller number of cases were observed in younger individuals and in elderly patients. This pattern indicates that thyroid nodules tend to become more apparent or clinically detectable with increasing age (Table 1).

The results demonstrate that more than half of the patients (56.7%) were between 31 and 50 years of age, indicating that thyroid swellings are particularly common in the middle-aged population, which is correlated with the other similar study [4].

Analysis of the gender distribution in the present study revealed that thyroid swellings were significantly more common in females than in males. Out of the 90 patients included in the study, 77 were female and 13 were male, giving a female-to-male ratio of approximately 6:1 (Table 1). The higher proportion of female patients reflects the well-recognized epidemiological trend that thyroid disorders occur more frequently in women. Hormonal influences, autoimmune predisposition, and endocrine factors have been suggested as possible explanations for this higher prevalence among females.

In the present study, 63 patients (70%) presented with solitary thyroid nodules, while 27 patients (30%) had multinodular enlargement of the thyroid gland (Table 1).

Solitary nodules were more common in this study population. This finding is clinically important because solitary nodules are often evaluated more carefully for the possibility of malignancy compared to multinodular enlargement.

All patients underwent high-resolution ultrasonography (HRUS) of the thyroid gland as part of the diagnostic evaluation. Ultrasonography provided important information regarding the size of the thyroid gland, number of nodules, composition, echogenicity, echogenic foci, margins, shape and extra-thyroid extension.

Based on ultrasonographic features, thyroid nodules were broadly categorized into those showing benign characteristics and those showing suspicious features suggestive of malignancy (5)(Table 1).

The majority of nodules showed benign characteristics such as well-defined margins, cystic components, and homogenous echotexture. However, 20 cases demonstrated suspicious features, including ill-defined margins, solid composition, hypoechoic, microcalcifications, or taller than wide lesion which warranted further cytological evaluation [6].

Table 1: Distribution of demographic, clinical and ultrasonographic characteristics of patients.

Variable	Category	No. of patients	Percentage (%)
Age Group (years)	21–30	12	13.3%
	31–40	24	26.7%
	41–50	27	30.0%
	51–60	18	20.0%
	61–70	9	10.0%
Gender	Male	13	14.4%
	Female	77	85.5%
Clinical presentation	Solitary thyroid nodule	63	70%
	Multinodular goitre	27	30%
Ultrasound findings	Benign features	70	77.8%
	Suspicious features	20	22.2%
Total		**90**	**100%**

All patients underwent ultrasound-guided fine needle aspiration cytology (FNAC) prior to surgery [7]. Cytological examination of the aspirated material allowed preliminary categorization of the thyroid lesions. The FNAC results showed that benign lesions constituted the largest group, while a smaller proportion of cases were categorized as malignant (Table 2 & Figure 1).

Table 2: Distribution of FNAC diagnosis

FNAC (Cytodiagnosis)			No. of patients	Percentage (%)
Benign	Non-Inflammatory	Colloid goitre	55	61.1%
		Toxic goitre	2	2.2%
		Colloid cyst	5	5.6%
	Inflammatory	Thyroiditis	6	6.7%
Malignant	Papillary Carcinoma		12	13.3%
	Anaplastic Carcinoma		2	2.2%
	Follicular Neoplasm		8	8.9%
Total			90	100%

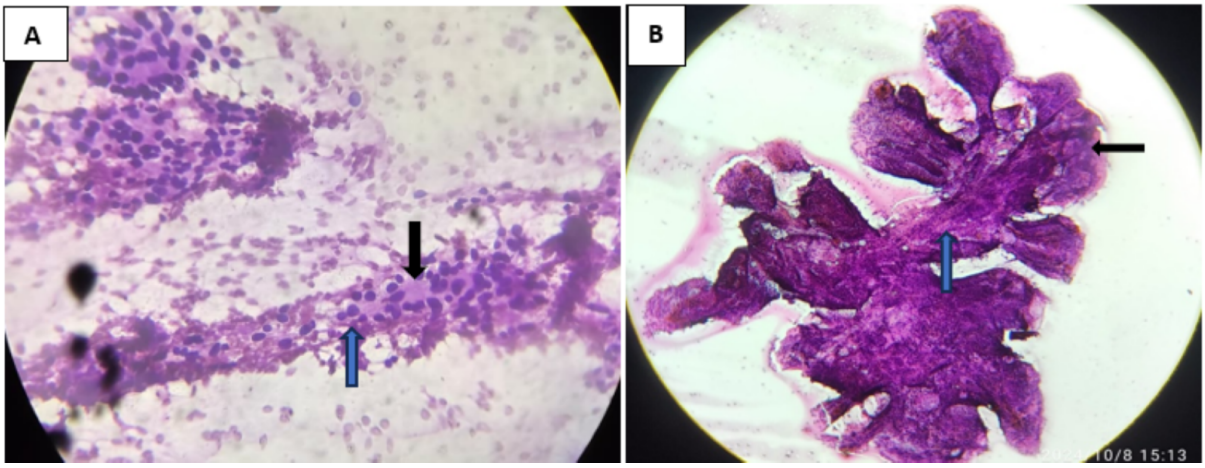

Figure 1: Fine needle aspiration cytology of thyroid lesions (Papanicolaou stain, X 20). (A) Benign thyroid cytology showing colloid (black arrow) and follicular epithelial cells (blue arrow). (B) Papillary carcinoma cytology showing papillary clusters (black arrow) with fibrovascular core (blue arrow).

The predominance of benign cytological findings reflects the general observation that most thyroid nodules are non-malignant [8]. However, the identification of cytology is important in guiding surgical management.

On FNAC, 68 cases were found to be benign, comprising 62 cases of non-inflammatory swelling and 6 cases of inflammation (thyroiditis). According to USG, 20 individuals had suspicious features of malignancy, of which 17 had thyroid gland cancer confirmed by FNAC and 3 had benign results. 68 of the 70 benign USG swellings were benign on FNAC, while 2 were malignant on FNAC. Following thyroidectomy, the excised specimens were sent for histopathological examination, which served as the definitive diagnostic method [9]. Histopathology allowed detailed evaluation of the tissue architecture, cellular morphology, and evidence of capsular or vascular invasion (Table 3; Figure 2).

Table 3: Histopathological diagnosis

HPE (Histopathological diagnosis)			No. of patients	Percentage (%)
Benign	Non-Inflammatory	Colloid goitre	58	64.4%
		Toxic goitre	2	2.2%
		Follicular adenoma	6	6.7%
	Inflammatory	Thyroiditis	7	7.7%
Malignant	Papillary Carcinoma		12	13.3%
	Anaplastic Carcinoma		1	2.2%
	Medullary Carcinoma		1	2.2%
	Non-Hodgkin's Lymphoma		1	2.2%
	Follicular Carcinoma		2	2.2%
Total			90	100%

Out of 90 patients underwent histopathological evaluation. The majority of cases were benign lesions, with non-inflammatory benign disorders accounting for most diagnoses. Among these, colloid goitre was the most common histopathological finding, observed in 58 patients (64.4%) followed by follicular adenoma, which was diagnosed in 6 patients (6.7%). Inflammatory benign

lesions were represented by thyroiditis, which was found in 7 patients (7.7%). Malignant lesions constituted a smaller proportion of the study population [10]. Papillary carcinoma was the most frequently encountered malignant neoplasm, diagnosed in 12 patients (13.3%) followed by Follicular carcinoma, which was identified in 2 patients (2.2%). Less common malignant tumors included anaplastic carcinoma, medullary carcinoma, and non-Hodgkin's lymphoma, each reported in 1 patient (2.2%). Histopathological examination remains the gold standard for establishing the definitive diagnosis and differentiating between benign and malignant thyroid lesions, thereby guiding appropriate patient management and treatment strategies.

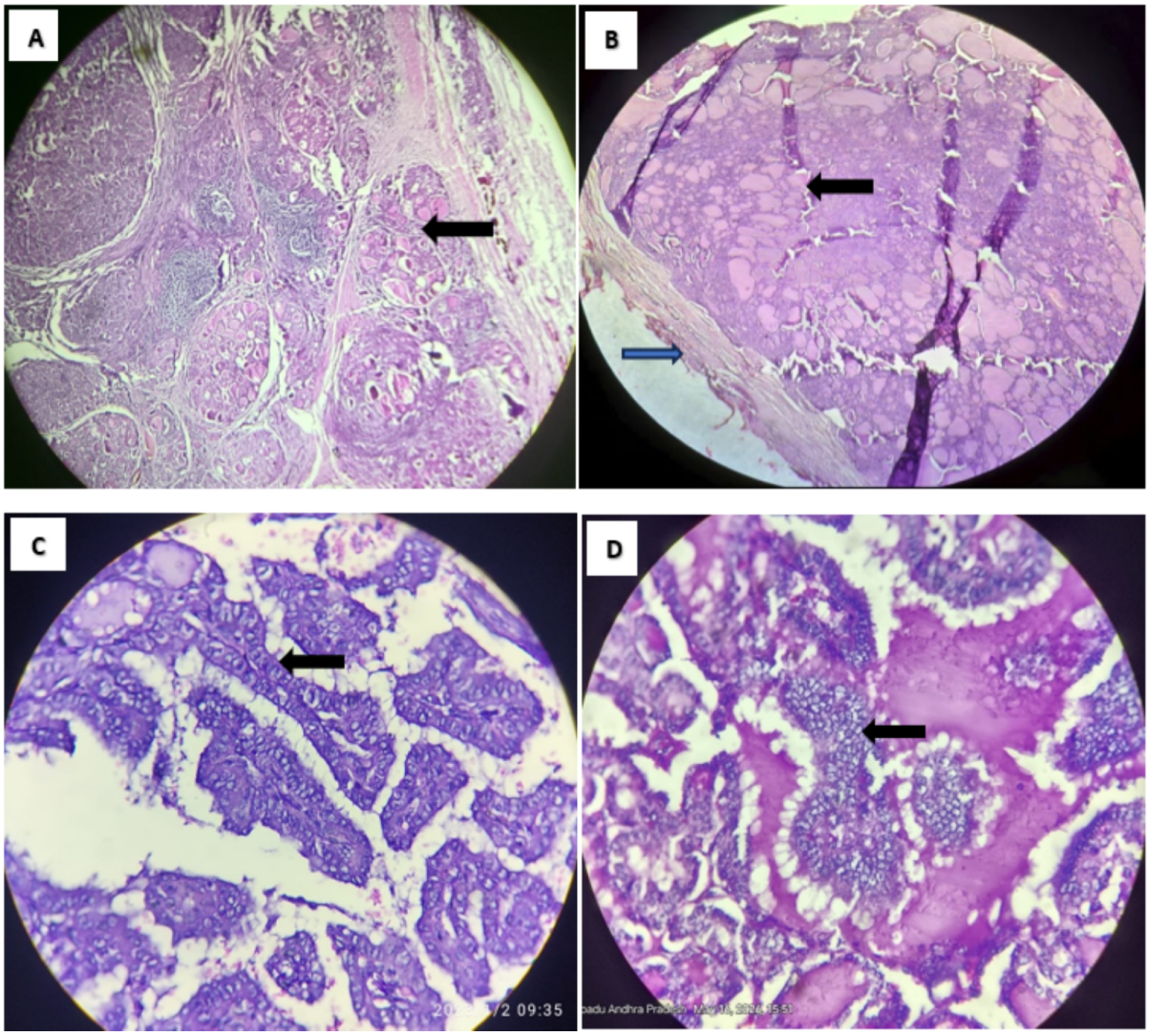

Figure 2: Histopathological features of thyroid lesions (Hematoxylin and Eosin stain). (A) Hashimoto thyroiditis with Hurthle cell change (x20). (B) Follicular adenoma with follicular architecture (black arrow) and intact capsule (blue arrow) (x20). (C) Papillary thyroid carcinoma showing papillary architecture with fibrovascular core (black arrow) (x20). (D) Papillary thyroid carcinoma showing Orphan Annie eye nuclei (x40).

In the histopathological diagnosis of our study, out of 55 colloid goitres (in FNAC), 53 cases are colloid goitre, and the rest 2 are diagnosed as thyroiditis in HPE.

In 6 cases of thyroiditis (in FNAC) 5 cases remain same and rest 1 turned out to be papillary carcinoma in HPE; 5 cases of colloid cyst (in FNAC) turned out to be colloid goitre in HPE, and 2 cases of toxic goitre remain the same in HPE as well. Out of 12 cases of papillary carcinoma in FNAC, 11 showed papillary carcinoma and 1 turned out to be medullary carcinoma in HPE. In 2 cases of anaplastic carcinoma, FNAC showed 1 remaining the same as anaplastic, and another turned out to be non-Hodgkin's lymphoma. 8 cases of follicular neoplasm in FNAC showed 6 follicular adenomas and 2 follicular carcinomas in HPE.

To evaluate the diagnostic performance of FNAC, the cytological findings were compared with the final histopathological diagnosis. This comparison

helps determine the reliability of FNAC as a preoperative diagnostic tool [11] (Table 4).

Table 4: Correlation between FNAC and histopathology

	HPE Malignant	HPE Benign	Total
FNAC Malignant	16 (TP)	6 (FP)	22
FNAC Benign	1 (FN)	67 (TN)	68
Total	17	73	90

Out of 22 cases were diagnosed to be a malignant on FNAC, 16(true positive-TP) were found to be malignant on histopathology while 6(False positive-FP) were found to be benign. 68 cases were found to be benign on FNAC out of which, 1(False negative-FN) was found to be malignant on histopathology and 67(true negative-TN) were found to be benign on histopathology. In our study FNAC showed a sensitivity of 94.12%, specificity of 91.78%, positive predictive value of 72.73%, negative predictive value of 98.53%, and an overall diagnostic accuracy of 92.22% when compared with histopathological examination (HPE).

A Chi-square test was performed to assess the association between FNAC diagnosis and histopathological examination (HPE) findings. The analysis demonstrated a highly significant association between FNAC and HPE results (χ^2 = 55.08, df = 1, $p < 0.00001$). This indicates that FNAC findings were strongly correlated with the final histopathological diagnosis and had excellent diagnostic performance in distinguishing benign from malignant thyroid lesions. This indicates that FNAC findings showed a meaningful association with the final tissue diagnosis [12].

Diagnostic accuracy of FNAC: The diagnostic performance of FNAC was evaluated by comparing its results with histopathology, which served as the gold standard. Overall diagnostic accuracy of FNAC is 92.22% in differentiating benign and malignant thyroid lesions when compared with histopathological examination.

These values indicate that FNAC is highly effective in identifying malignant thyroid lesions while also reliably confirming benign conditions.

Discussion

Thyroid nodules are among the most frequently encountered endocrine disorders in surgical practice. Although the majority of thyroid lesions are benign, differentiation between benign and malignant nodules remains essential for determining appropriate management. Fine needle aspiration cytology (FNAC), particularly when performed under ultrasound guidance, has become the cornerstone of preoperative evaluation because it is minimally invasive, cost-effective, and associated with high diagnostic accuracy [13,14]. In the present cross sectional study, the majority of patients belonged to the 41–50-year age group, with females constituting 85.5% of the study population. These findings are consistent with previous studies that have reported a higher prevalence of thyroid disorders among middle-aged women. Gharib et al. [15] demonstrated that thyroid nodules increase in frequency with age and are significantly more common in females due to hormonal influences and a higher prevalence of autoimmune thyroid disease. Solitary thyroid nodules constituted 70% of cases in our study, while multinodular goitre accounted for 30%. Similar observations have been reported by Wang [16], who noted that solitary nodules frequently warrant detailed evaluation because of their relatively greater association with malignancy.

Ultrasonography revealed benign characteristics in 77.8% of nodules and suspicious features in 22.2%. High-resolution ultrasonography plays a crucial role in risk stratification and selection of nodules for aspiration. Suspicious sonographic findings such as irregular margins, microcalcifications, taller than wide lesions, and marked hypo echogenicity have been shown to correlate strongly with malignancy.

In the present study, FNAC categorized 75.5% of lesions as benign and 24.4% as malignant. Histopathological examination subsequently demonstrated benign lesions in 73.3% and malignant lesions in 26.6% of patients. The predominance of benign lesions observed in our series is comparable to findings reported by Handa et al. [6], who noted that most thyroid nodules are non-neoplastic and can be managed conservatively following appropriate evaluation.

A significant correlation was observed between FNAC and HPE results (χ^2 = 55.08, df = 1, $p < 0.00001$), indicating that cytological diagnosis closely reflects the final tissue diagnosis. Similar results have been reported by Gupta et al. [13], Sengupta et al. [11], and Mazeh et al. [8], who demonstrated strong agreement between preoperative FNAC and postoperative histopathology.

The diagnostic performance of ultrasound-guided FNAC in the present study was excellent, with sensitivity of 94.12%, specificity of 91.78%, positive predictive value of 72.73%, negative predictive value of 98.53%, and an overall diagnostic accuracy of 92.22%. These findings are comparable to those reported by Gupta et al. [13] and other published studies demonstrating

diagnostic accuracies exceeding 85–90%. Despite its high accuracy, FNAC has certain limitations. False-negative results may occur because of sampling errors, cystic degeneration, or heterogeneous nodules, while follicular adenoma and follicular carcinoma cannot be reliably distinguished cytologically because capsular and vascular invasion can only be assessed histologically. Therefore, FNAC findings should always be interpreted in conjunction with clinical and ultrasonographic features.

Overall, the present study confirms that ultrasound-guided FNAC is a highly reliable preoperative diagnostic tool for thyroid swellings and demonstrates excellent correlation with histopathological examination. Its routine use can facilitate early diagnosis of malignancy, reduce unnecessary surgical interventions, and improve clinical decision-making in patients with thyroid nodules [13].

Conclusion

Ultrasound-guided FNAC demonstrates excellent diagnostic accuracy and significant correlation with histopathological examination. It remains a safe, minimally invasive, economical, and highly effective first-line investigation for thyroid swellings. The high sensitivity, specificity, and negative predictive value observed in this study support its continued use as the primary diagnostic modality in thyroid nodule evaluation and surgical planning.

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