

Original Research Article

Diagnostic Validity of Ultrasound-Guided Fine Needle Aspiration Cytology in the Evaluation of Thyroid Swellings

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ABSTRACT

Background: Thyroid nodules are frequently encountered in clinical practice, and differentiating benign from malignant lesions is essential for appropriate management. FNAC (Fine Needle Aspiration Cytology) is the standard diagnostic technique; however, conventional palpation-guided FNAC may produce inadequate samples and false-negative results. Ultrasound-guided FNAC allows precise localization of thyroid nodules and targeted sampling, potentially improving diagnostic accuracy while reducing unnecessary surgeries and treatment costs. This study evaluated the diagnostic validity of ultrasound-guided FNAC compared with conventional palpation-guided FNAC in patients with thyroid swellings.

Methods: A diagnostic test evaluation (cross-sectional) study was conducted over one year in the Department of General Surgery, Government Medical College, Thrissur, Kerala. Ninety-six patients with clinically diagnosed thyroid swellings were randomly allocated into two groups: 48 underwent ultrasound-guided FNAC and 48 underwent conventional palpation-guided FNAC before thyroid surgery. Histopathological examination of surgical specimens served as the reference standard. Data were analyzed using SPSS, and sensitivity, specificity, PPV (Positive Predictive Value), NPV (Negative Predictive Value), and diagnostic accuracy were calculated.

Results: Among the 96 participants, 81 (84.4%) were females and 15 (15.6%) were males, with a mean age of 42.69 ± 11.3 years. Histopathology confirmed thyroid malignancy in 24 patients. Ultrasound-guided FNAC demonstrated a sensitivity of 90.9%, specificity of 97.3%, PPV of 90.9%, NPV of 97.3%, and diagnostic accuracy of 95.83%. In comparison, conventional palpation-guided FNAC showed a sensitivity of 53.84%, specificity of 94.28%, PPV of 77.77%, NPV of 84.61%, and diagnostic accuracy of 83.33%.

Conclusion: Ultrasound-guided FNAC is a superior diagnostic modality for evaluating thyroid swellings. It significantly improves sensitivity, diagnostic accuracy, and positive predictive value while reducing false-negative results compared with conventional palpation-guided FNAC. Routine use of ultrasound guidance is recommended wherever available to optimize the diagnosis and management of thyroid nodules.

Keywords: Ultrasound-Guided FNAC, Thyroid Swellings, Thyroid Nodules, Fine Needle Aspiration Cytology, Diagnostic Accuracy, Thyroid Malignancy.

INTRODUCTION

Thyroid nodules are among the most commonly encountered conditions in clinical practice. With the advent of high-frequency ultrasound (US) devices, thyroid nodules as small as 2–3 mm can be detected, resulting in an increase in the reported prevalence of thyroid nodules to as high as 68% in recent studies.^[1–3] Although the majority of thyroid

nodules are benign, approximately 5–15% are ultimately confirmed as malignant following surgical evaluation.^{4,5} Therefore, current clinical guidelines recommend US-FNA (Ultrasound-Guided Fine Needle Aspiration) as the standard diagnostic procedure for differentiating benign from malignant thyroid nodules, as its findings play a crucial role in determining appropriate management.^[1,4]

Compared with palpation-guided fine needle aspiration, routine use of ultrasound guidance has significantly reduced the rates of non-diagnostic samples and false-negative results by enabling precise targeting of suspicious nodules. This improved accuracy has contributed to a reduction in unnecessary surgical procedures for benign thyroid nodules while simultaneously increasing the detection rate of thyroid malignancies in thyroidectomy specimens.^[4-6]

The diagnostic accuracy of FNAC and the rate of inadequate specimens are influenced by several factors, including operator technique, experience, and the ability to accurately place the needle within the area of interest, particularly in cystic nodules. Ultrasound-guided FNAC offers several advantages by facilitating precise localization of the lesion, improving needle placement into the most representative area, and enabling aspiration of the solid component of cystic nodules that may be too small or inaccessible for palpation. Consequently, ultrasound-guided FNAC has the potential to substantially reduce inadequacy rates and improve the overall diagnostic yield of thyroid nodule evaluation.

Aims and Objectives

The present study was undertaken to assess the diagnostic validity of USG-FNAC (Ultrasound-Guided Fine Needle Aspiration Cytology) in the evaluation of thyroid swellings. The objective was to compare the diagnostic validity of ultrasound-guided FNAC with conventional palpation-guided FNAC among patients presenting with thyroid swellings to the Department of Surgery, Government Medical College, Thrissur.

MATERIALS AND METHODS

Study Design

This study was designed as a diagnostic test evaluation with a cross-sectional design and was conducted in the Department of General Surgery, Government Medical College, Thrissur, Kerala, India.

Inclusion and Exclusion Criteria

Patients attending the Surgery Outpatient Department with a clinical diagnosis of thyroid swelling and who were willing to participate in the study were included. Patients with significant disabling comorbidities rendering them unfit for thyroid surgery and those who underwent FNAC of the thyroid but did not

subsequently undergo thyroid surgery were excluded from the study.

Sample Size Calculation

Sample size (N) was calculated by the formula:

$N = a / \text{prevalence}$

Where,

$a = \text{sensitivity} (1 - \text{specificity}) / (\text{deviation})^2$

Considering the reference study^[7] sensitivity is 81% and specificity is 92% with 2%

The deviation and prevalence of thyroid neoplasm were 8%.

Minimum sample size is calculated as 48.

Among the total patients, 48 patients were selected for USG guided FNAC and another 48 patients were selected for palpation guided FNAC, on a random basis.

Data Collection Procedure

After obtaining written informed consent from all participants, socio-demographic information and relevant clinical details, including age of onset, duration of illness, and other clinical findings, were recorded using a predesigned proforma. Patients with clinically diagnosed thyroid swellings underwent ultrasound-guided fine-needle aspiration cytology (USG-guided FNAC) in the Department of Radiodiagnosis, where the procedure was performed by the investigator under ultrasound guidance. Cytological smears were reported by the Department of Pathology. An equal number of patients with clinically diagnosed thyroid swellings also underwent conventional palpation-guided FNAC in the Department of Pathology. Following thyroidectomy, HPE (Histopathological Examination) reports were obtained from the Department of Pathology, and the findings were compared with the FNAC results to assess the diagnostic validity of ultrasound-guided FNAC in comparison with conventional palpation-guided FNAC.

Statistical Analysis

The data collected during the study were entered into Microsoft Excel and subsequently analyzed using Statistical Package for the Social Sciences (SPSS) software. The diagnostic performance of ultrasound-guided FNAC and conventional palpation-guided FNAC was evaluated separately by comparing the cytological findings with histopathological examination, which was considered the gold standard.

	Histopathology Positive	Histopathology Negative
FNAC Positive	a	b
FNAC Negative	c	d

Here two separate tables are prepared for guided and palpation guide FNAC.

Sensitivity of USG guided FNAC= $a/(a+c) \times 100\%$.

Specificity of USG guided FNAC = $d/(b+d) \times 100\%$.

Positive predictive value = $a/(a+b) \times 100\%$.

Negative predictive value = $d/(d+c) \times 100\%$.

Diagnostic accuracy: $(a+d)/(a+b+c+d) \times 100\%$.

RESULTS

Variable	Number	Percentage
Total participants	96	100
Mean age (years)	42.69 ± 11.3	—
Male	15	15.6
Female	81	84.4
Total malignant cases	24	25.0
Malignant males	7	29.2*
Malignant females	17	70.8*

Table 1. Demographic Characteristics and Malignancy Distribution

Percentage among malignant cases (n=24).

Table 1 illustrates the demographic profile of the study population. Females accounted for the majority of thyroid swelling

cases (84.4%). Although fewer males presented with thyroid swellings, a relatively higher proportion of males were diagnosed with malignancy compared with females.

Clinical Feature	Number	Percentage
Pain	2	2.1
Pain with malignancy	1	50.0+
Hypothyroid symptoms	29	30.2
Hyperthyroid symptoms	7	7.3
Cervical lymphadenopathy	8	8.3
Cervical lymphadenopathy with malignancy	8	100

Table 2. Clinical Presentation of Thyroid Swelling

Table 2 summarizes the clinical presentation of patients with thyroid swellings. Hypothyroid symptoms were more common than hyperthyroid symptoms. All patients

presenting with significant cervical lymphadenopathy were subsequently confirmed to have malignant thyroid disease on histopathology.

Consistency	Total Cases	Percentage	Malignant Cases	Malignancy Rate (%)
Soft	51	53.1	1	2.0
Firm	37	38.5	15	40.5
Hard	8	8.3	8	100
Total	96	100	24	—

Table 3. Consistency of Thyroid Swelling and Association with Malignancy

Table 3 demonstrates the relationship between the consistency of thyroid swellings and malignancy. Soft swellings were predominantly benign, whereas every patient

with a hard thyroid swelling was diagnosed with malignancy on final histopathological examination.

Histopathological Diagnosis	Number	Percentage
Benign lesions	72	75.0
Papillary carcinoma	22	22.9
Follicular carcinoma	1	1.0
Poorly differentiated carcinoma	1	1.0
Total	96	100

Table 4. Histopathological Diagnosis of Thyroid Lesions

Table 4 presents the final histopathological diagnosis of the study population. Benign lesions constituted three-

fourths of all thyroid swellings, while papillary carcinoma emerged as the predominant malignant lesion.

Ultrasound-Guided FNAC	Histopathology Positive	Histopathology Negative	Total
FNAC positive	10	1	11
FNAC negative	1	36	37
Total	11	37	48

Table 5. Ultrasound-Guided FNAC Compared with Histopathology (n=48)

Table 5 illustrates the diagnostic performance of ultrasound-guided FNAC using histopathology as the reference standard. The ultrasound-guided technique produced only

one false-positive and one false-negative result, indicating excellent agreement with histopathological findings.

Palpation-Guided FNAC	Histopathology Positive	Histopathology Negative	Total
FNAC positive	7	2	9
FNAC negative	6	33	39
Total	13	35	48

Table 6. Palpation-Guided FNAC Compared with Histopathology (n=48)

Table 6 shows the diagnostic accuracy of palpation-guided FNAC. Compared with ultrasound guidance, palpation-guided FNAC

demonstrated a higher number of false-negative cases, suggesting reduced sensitivity for detecting thyroid malignancy.

Diagnostic Parameter	Ultrasound-Guided FNAC	Palpation-Guided FNAC
Sensitivity	90.9%	53.84%
Specificity	97.3%	94.28%
Positive Predictive Value	90.9%	77.77%
Negative Predictive Value	97.3%	84.61%
Diagnostic Accuracy	95.83%	83.33%

Table 7. Comparison of Diagnostic Validity of Ultrasound-Guided and Palpation-Guided FNAC

Table 7 compares the overall diagnostic performance of both FNAC techniques. Ultrasound-guided FNAC demonstrated substantially higher sensitivity and diagnostic accuracy while maintaining excellent specificity, making it the superior modality for evaluating thyroid nodules.

DISCUSSION

The total number of patients included in this study is 96. And the mean age is 42.69. The study population includes 15 males and 81 females, with a predominance for females. In the study population male patients are having a high malignancy rate of 46.7% (7 out of 15

males with thyroid swelling had malignancy), which was found to be statistically significant ('p' value 00.035)

The commonest diagnosis was nodular colloid goiter and among malignancies, the predominant one was papillary carcinoma thyroid. Most of the patients who presented with thyroid swellings were clinically euthyroid (62.5%). Most of the thyroid swellings were soft in consistency (53.1%) and they had a very low malignancy rate (2%). Out of 96 patients 8 patients (8.3%) had thyroid swellings, which are hard in consistency and all of them were malignant in their final histopathology report. This suggests that

whenever a patient presents with a hard thyroid swelling, there is a high chance of malignancy in it.

Out of 96 patients with thyroid swellings, 24 patients had malignancies in their final histopathology report. In the ultrasound-guided group there was one false negative result, and in the other group, which underwent conventional palpation-guided FNAC, there were 6 false negative results. This shows that ultrasound-guided FNAC plays a major role in reducing false negative results of thyroid FNAC.

In ultrasound guided group, the sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of FNAC was found to be 90.9%, 97.3%, 90.9%, 97.3% and 95.83% respectively. And in conventional palpation guided group the sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of FNAC were found to be 53.84%, 94.28%, 77.77%, 84.61% and 83.33% respectively. This suggests that ultrasound guided FNAC is having a high sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy compared to conventional palpation guided FNAC group. This suggests that ultrasound guided FNAC is superior in the evaluation of thyroid swellings to conventional FNAC.

The demographic profile in the present series, a marked female preponderance (84.4%) with a mean age in the fifth decade, is consistent with several Indian series on thyroid swellings. Chaudhary et al, in a study of thyroid swellings, reported a female-to-male ratio of 7.3:1 with the majority of patients in the 3rd and 4th decades of life,^[8] while a prospective study evaluating FNAC of thyroid nodules found a similar female preponderance of 82.3% with a comparable mean age of 41.6 years.^[9] Although thyroid swellings occur far more often in women, the higher malignancy rate observed among male patients in this study (46.7%, $p=0.035$) mirrors a consistent finding across the world literature. Elbalka et al., in a retrospective cohort of 1000 thyroid nodules, identified male sex as one of the significant clinical predictors of malignancy on univariate analysis,^[10] and Cañete et al., reported male gender as an independent predictor of malignancy (odds ratio 2.4) among Filipino patients with thyroid nodules.^[11] Similarly, Mettler et al, analysing four years of data from an endocrine tumour

board, found that male patients with nontoxic thyroid nodules had a significantly higher malignancy rate of 40% compared with females ($p=0.04$),^[12] a finding numerically very close to the malignancy rate seen among males in the present study. Taken together, these studies support male sex as a red-flag clinical feature that should heighten suspicion for malignancy even though thyroid disease itself is far commoner in women.

The strong association between hard consistency of the thyroid swelling and malignancy noted in this study, with all eight patients (100%) having a hard nodule turning out to be malignant on final histopathology, and firm nodules carrying a 40.5% malignancy rate, is well supported by the literature on clinical predictors of thyroid malignancy. Cañete et al., on multivariate logistic regression analysis of thyroid nodules, found that the presence of a hard or firm nodule increased the likelihood of malignancy by odds ratios of 58.8 and 12.8 respectively, making consistency one of the strongest independent clinical predictors identified in that study.^[11] In a similar vein, Chiofalo et al., in a multicentre prospective study of palpable thyroid nodules, showed that hard consistency combined with small nodule size was a strong independent predictor of malignancy (odds ratio 3.51).^[13] These findings validate hard or firm consistency on palpation as a simple, cost-free clinical sign that should prompt early and thorough evaluation of a thyroid swelling. Likewise, the presence of significant cervical lymphadenopathy was found exclusively among malignant cases in this study, all eight patients with clinically palpable lymph nodes proving malignant, and accounted for a third of all malignancies. This is in agreement with recent work by Al Argan et al., who, in a multicentre study of indeterminate thyroid nodules, identified lymph node involvement as an independent predictor of malignancy with an odds ratio of 2.43,^[14] reinforcing that clinically evident cervical lymphadenopathy accompanying a thyroid swelling should be regarded as a high-risk feature warranting urgent tissue diagnosis.

On histopathological analysis, papillary carcinoma accounted for 22 of the 24 malignancies (91.7%) in this study, with follicular and poorly differentiated carcinoma each contributing a single case. This overwhelming predominance of papillary histology among thyroid malignancies is a near-universal finding in the literature.

Chaudhary et al found papillary carcinoma to be the most common malignant lesion among thyroid swellings evaluated clinically, sonologically and cytologically,^[8] and a similar predominance of papillary carcinoma among malignant thyroid aspirates was reported in a prospective evaluation of FNAC using the Bethesda system.^[9] Haiyat et al., in a cyto-histomorphological analysis of 559 patients at a North Indian tertiary oncology centre, likewise found papillary thyroid carcinoma to be the most common malignancy encountered.^[15] This consistency across geographically diverse populations underscores papillary carcinoma as the histological subtype that clinicians must remain most vigilant for while evaluating thyroid swellings, regardless of the guidance technique used for FNAC.

The central finding of this study, that ultrasound guided FNAC was markedly superior to conventional palpation guided FNAC across every diagnostic parameter (sensitivity 90.9% vs. 53.84%, specificity 97.3% vs. 94.28%, positive predictive value 90.9% vs. 77.77%, negative predictive value 97.3% vs. 84.61%, and diagnostic accuracy 95.83% vs. 83.33%), is strongly corroborated by comparable studies from other settings. Izquierdo et al, in a comparison of palpation guided versus ultrasound guided FNAC performed in an outpatient endocrinology practice, reported that ultrasound guidance improved the cytological diagnostic accuracy from 60.9% to 80%, along with an improvement in sensitivity and positive predictive value and a reduction in the false-negative rate compared with palpation guided FNAC,^[16] a pattern of improvement that closely parallels the magnitude of benefit observed in the present series, particularly the fall in false negative results from six in the palpation guided group to only one in the ultrasound guided group.

A systematic review and meta-analysis by Tarigan et al., pooling data from 11 studies comprising 2382 subjects, similarly concluded that ultrasound guided FNAC achieved superior pooled diagnostic accuracy over palpation guided FNAC, although the authors noted some heterogeneity across the included studies.^[17] It is worth acknowledging that not every published comparison has shown a statistically significant difference between the two techniques, particularly in smaller series or where the same experienced operator performed both procedures, and some authors

have questioned whether routine ultrasound guidance is essential in all settings; however, the overwhelming majority of comparative literature, and the results of the present study, favour ultrasound guidance, especially in reducing the false-negative rate that is of greatest clinical consequence.

The present findings are read alongside this body of literature, a consistent picture emerges: thyroid swellings predominantly affect women but carry a disproportionately higher malignancy risk in men; hard consistency and clinically evident cervical lymphadenopathy are simple bedside features that strongly predict malignancy; papillary carcinoma remains the histological subtype encountered most often; and ultrasound guidance meaningfully improves every diagnostic performance parameter of FNAC compared with the conventional palpation guided technique, chiefly by reducing false-negative results. These convergent observations across populations as varied as India, the Philippines, Egypt, Germany, Saudi Arabia and the United States lend considerable external validity to the conclusions drawn from this study.

CONCLUSION

In the present study, ultrasound-guided fine needle aspiration cytology (USG-guided FNAC) proved to be a superior diagnostic modality for the evaluation of thyroid nodules compared with conventional palpation-guided FNAC. USG-guided FNAC demonstrated higher diagnostic accuracy, sensitivity, specificity, and positive predictive value, while significantly reducing the false-negative rate. By improving the precision of diagnosis, it facilitates timely and cost-effective clinical management of thyroid lesions. Based on the findings of this study, the routine use of ultrasound-guided FNAC is recommended for the evaluation of thyroid swellings whenever feasible.

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