Original Article

Role of Ultrasound-Guided FNAC in the Evaluation of Thyroid Nodules: A Prospective Study

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Abstract

Background: Thyroid nodules are common endocrine lesions, and distinguishing benign from malignant nodules is essential for appropriate management. Ultrasound-guided fine-needle aspiration cytology (USG-guided FNAC) improves sampling accuracy and is considered the investigation of choice for evaluating thyroid nodules. The objective is to evaluate the diagnostic role of ultrasound-guided FNAC in thyroid nodules and assess its cytological adequacy, diagnostic accuracy, and cyto-histopathological correlation. **Material and Methods:** This prospective observational study included 110 patients with thyroid nodules who underwent ultrasound-guided FNAC. Nodules were assessed using high-resolution ultrasonography, and cytological findings were reported according to the Bethesda System for Reporting Thyroid Cytopathology. Histopathological correlation was performed in surgically managed cases. Diagnostic indices including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy were calculated. **Results:** Females constituted 78.2% of the study population, and solitary thyroid nodules were observed in 58.2% of patients. Bethesda Category II (Benign) was the most frequent cytological diagnosis (60%), while only 3.6% of aspirates were non-diagnostic. Histopathological correlation showed 94.1% concordance between cytology and histopathology. Ultrasound-guided FNAC demonstrated a sensitivity of 93.3%, specificity of 97.1%, positive predictive value of 93.3%, negative predictive value of 97.1%, and an overall diagnostic accuracy of 95.6%. Suspicious ultrasonographic features including microcalcifications, irregular margins, hypoechogenicity, and increased intranodular vascularity were significantly associated with malignant cytological diagnoses ($p<0.05$). **Conclusion:** Ultrasound-guided FNAC is a highly accurate, safe, and minimally invasive technique for evaluating thyroid nodules. Its excellent diagnostic performance, low inadequacy rate, and strong cyto-histopathological correlation make it an indispensable tool for the early diagnosis and appropriate management of thyroid malignancies.

Keywords: Thyroid nodules, ultrasound-guided FNAC, thyroid cytology, Bethesda System, ultrasonography, thyroid cancer, histopathology.

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Introduction

Thyroid nodules are among the most frequently encountered endocrine disorders in clinical practice, with a prevalence of approximately 4–7% on clinical examination and up to 60–70% when evaluated by high-resolution ultrasonography. Although most thyroid nodules are benign, approximately 5–15% are malignant, making accurate preoperative diagnosis essential to ensure appropriate management while avoiding unnecessary thyroid surgery.[1]

High-resolution ultrasonography (USG) has become the primary imaging modality for the evaluation of thyroid nodules because of its ability to detect even small lesions, assess nodule size, composition, echogenicity, margins, calcifications, vascularity, and cervical lymph node involvement.[2,3] Ultrasound-based risk stratification systems such as the American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS) and the European Thyroid Imaging Reporting and Data System (EU-TIRADS) have improved the selection of nodules requiring biopsy by categorizing lesions according to their risk of malignancy.[4-6]

Fine-needle aspiration cytology (FNAC) is regarded as the investigation of choice for the preoperative evaluation of thyroid nodules because it is simple, minimally invasive, cost-effective, and highly accurate. Ultrasound guidance has further enhanced the diagnostic performance of FNAC by improving needle placement, particularly in small, deeply located, predominantly cystic, posteriorly situated, or non-palpable nodules. Ultrasound-guided FNAC also reduces the incidence of inadequate or non-diagnostic aspirates and improves sampling accuracy from suspicious areas within heterogeneous nodules.[1,4,7]

To standardize cytological interpretation and facilitate communication between clinicians and cytopathologists, the Bethesda System for Reporting Thyroid Cytopathology

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(TBSRTC) classifies thyroid FNAC findings into six diagnostic categories, each associated with an estimated risk of malignancy and specific management recommendations. The widespread adoption of the Bethesda System has improved reporting consistency, diagnostic reproducibility, and clinical decision-making across healthcare institutions.[3] Several studies have demonstrated that ultrasound-guided FNAC has superior diagnostic accuracy compared with palpation-guided aspiration, especially in nodules with suspicious ultrasonographic features. Meta-analyses have shown high sensitivity and specificity of ultrasound-guided FNAC for diagnosing thyroid malignancy, supporting its routine use in the evaluation of thyroid nodules. Nevertheless, continuous assessment of its diagnostic performance in different populations remains necessary to optimize patient care and minimize false-negative and inadequate results.[7,8]

The present prospective study was therefore undertaken to evaluate the role of ultrasound-guided FNAC in the diagnosis of thyroid nodules, determine the adequacy of cytological sampling, assess the distribution of Bethesda categories, and evaluate the diagnostic accuracy of ultrasound-guided FNAC in comparison with histopathological findings wherever available.

Materials and Methods

Study Design: This was a prospective observational study conducted to evaluate the diagnostic role of ultrasound-guided fine-needle aspiration cytology (USG-guided FNAC) in patients presenting with thyroid nodules.

Study Setting: The study was carried out in the Department of Pathology in collaboration with the Departments of Radiodiagnosis, General Surgery, and Otorhinolaryngology at a tertiary care teaching hospital.

Study Duration: The study was conducted over a period of 24 months after obtaining approval from the Institutional Ethics Committee.

Sample Size: A total of 110 patients with thyroid nodules were included in the study.

Study Population: Patients presenting with clinically palpable or ultrasonographically detected thyroid nodules and referred for ultrasound-guided FNAC were enrolled.

Inclusion Criteria

- Patients aged 18 years and above with thyroid nodules detected clinically or on ultrasonography.
- Patients undergoing ultrasound-guided FNAC.
- Patients providing written informed consent.
- Patients with solitary or multiple thyroid nodules.

Exclusion Criteria

- Patients with bleeding disorders or receiving anticoagulant therapy that contraindicated FNAC.
- Patients with diffuse thyroid enlargement without discrete nodules.
- Previously diagnosed or treated thyroid malignancy.
- Inadequate clinical or imaging records.
- Patients unwilling to participate in the study.

Study Procedure: After obtaining informed written consent, demographic details, clinical history, duration of swelling, thyroid function status, and relevant laboratory investigations were recorded.

All patients underwent high-resolution ultrasonography using a 7.5–15 MHz linear-array transducer. Ultrasonographic assessment included:

- Nodule size
- Number of nodules
- Location
- Composition (solid, cystic, mixed)
- Echogenicity
- Margins
- Shape
- Presence of microcalcifications
- Halo sign
- Internal vascularity
- Cervical lymph node status

The thyroid nodules were classified using the ACR TI-RADS system.

Aseptic precautions were taken during the procedure using a 23–25 G needle attached to a 10 mL disposable syringe for obtaining FNAC. The needling area was estimated by real-time ultrasonographic measurement to insure proper placement of the needle in the most probable area of the lesion. 2-4 passes were taken as needed.

Immediately smears were made and air dried for May-Grünwald-Giemsa (MGG) staining and Papanicolaou (Pap) alcohol fixing. Cytological findings are discussed in the context of The Bethesda System for Reporting Thyroid Cytopathology (Second Edition). Thyroid surgery patients that were performed later then had routine processing of their specimens. For correlation, hematoxylin and eosin (H&E) stained sections were examined by a histopathological process to act as the reference standard.

Study Variables

The following variables were analyzed:

- Age and gender
- Clinical presentation
- Ultrasonographic characteristics of thyroid nodules
- TI-RADS category
- Bethesda category
- Adequacy of FNAC samples
- Histopathological diagnosis (where available)
- Cyto-histopathological correlation

Outcome Measures

Primary Outcome

- Diagnostic accuracy of ultrasound-guided FNAC in the evaluation of thyroid nodules.

Secondary Outcomes

- Adequacy rate of ultrasound-guided FNAC.
- Distribution of Bethesda categories.
- Correlation between ultrasound risk stratification (TI-RADS) and cytological diagnosis.
- Histopathological correlation in operated cases.
- Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy of ultrasound-guided FNAC.

Statistical Analysis: The data collected were transferred to Microsoft Excel and were analyzed using SPSS (Version 25.0). Means and standard deviations (SD) were used for data of continuous variables, and frequencies and percentages for data of

categorical variables. The Chi-square test or Fisher's exact test was used to assess the associations between the ultrasonographic findings and the Bethesda categories with histopathological diagnosis. Histopathology was used as the 'gold standard' with diagnostic indices such as sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) and overall diagnostic accuracy determined. A p value of < 0.05 was taken as statistically significant.

Results

A total of 110 patients with thyroid nodules underwent ultrasound-guided fine-needle aspiration cytology (USG-guided FNAC). Cytological findings were categorized according to the Bethesda System for Reporting Thyroid Cytopathology (TBSRTC). Histopathological correlation was available in patients who subsequently underwent surgery.

Table 1: Demographic Profile of the Study Population (n = 110)

Variable	Number (n)	Percentage (%)
Age Group (Years)		
18–30	18	16.4
31–45	42	38.2
46–60	35	31.8
>60	15	13.6
Gender		
Male	24	21.8
Female	86	78.2
Clinical Presentation		
Solitary thyroid nodule	64	58.2
Multinodular goitre	46	41.8

Most patients belonged to the 31–45 years age group (38.2%). Females constituted 78.2% of the study population, giving a female-to-male ratio of approximately 3.6:1. Solitary thyroid nodules were more common (58.2%) than multinodular goitre.

Table 2: Ultrasound Characteristics and Bethesda Cytology Categories (n = 110)

Variable	Number (n)	Percentage (%)
Ultrasound Features		
Solid nodule	68	61.8
Mixed solid-cystic	28	25.5
Predominantly cystic	14	12.7
Hypoechoic lesion	50	45.5
Microcalcifications	24	21.8
Irregular margins	20	18.2
Increased intranodular vascularity	30	27.3
Bethesda Category		
I – Non-diagnostic	4	3.6
II – Benign	66	60.0
III – AUS/FLUS	10	9.1
IV – Follicular Neoplasm	11	10.0
V – Suspicious for Malignancy	7	6.4
VI – Malignant	12	10.9

Solid thyroid nodules (61.8%) were the predominant ultrasonographic finding. Bethesda Category II (Benign) accounted for 60% of cases, while only 3.6% of aspirates were non-diagnostic, indicating a high adequacy rate of ultrasound-guided FNAC.

Table 3: Diagnostic Performance of Ultrasound-Guided FNAC (Histopathological Correlation Available Cases)

Parameter	Value
Histopathological correlation available	68
Cyto-histopathological concordance	64 (94.1%)
Sensitivity	93.3%
Specificity	97.1%
Positive Predictive Value (PPV)	93.3%
Negative Predictive Value (NPV)	97.1%
Overall Diagnostic Accuracy	95.6%
Inadequate aspirates	4 (3.6%)
p-value	<0.001

Ultrasound-guided FNAC demonstrated excellent diagnostic performance, with an overall diagnostic accuracy of 95.6%. Histopathological correlation showed 94.1% concordance between cytological and histopathological diagnoses. The

low rate of inadequate aspirates (3.6%) highlights the effectiveness of ultrasound guidance in obtaining representative samples.

Table 4: Correlation of Suspicious Ultrasound Features with Malignant Cytology

Ultrasound Feature	Malignant Cytology (Bethesda V & VI) n (%)	Benign/Indeterminate Cytology n (%)	p-value
Microcalcifications Present (n=24)	16 (66.7)	8 (33.3)	<0.001
Irregular Margins Present (n=20)	15 (75.0)	5 (25.0)	<0.001
Hypoechogenicity Present (n=50)	20 (40.0)	30 (60.0)	0.002
Increased Intranodular Vascularity (n=30)	14 (46.7)	16 (53.3)	0.018

Suspicious ultrasonographic features such as microcalcifications, irregular margins, hypoechogenicity, and increased intranodular vascularity were significantly associated with malignant cytological diagnoses (Bethesda Categories V and VI). These findings support the role of ultrasound in selecting nodules for FNAC and improving the diagnostic yield of thyroid nodule evaluation.

Discussion

Fine-needle aspiration cytology (FNAC) is the standout diagnosis technique for thyroid nodules, given the benefits of its ability to provide high-resolution imaging and cytological sampling. In the present prospective study, USG guided FNAC was found to be highly useful with 100% adequacy, high degree of accuracy and good cyto-histopathological correlation.

The female population showed the highest rate (78.2%) in the present study, the highest rate being in the age group of 31-45 which is highest. The age distribution is similar to the thyroid nodular disease, which has been observed to have a female preponderance. Similar findings were noted by Poller and Bongiovanni and they stressed that FNAC should be indispensable in the female population due to hormones and auto-immune factors, which play a significant role in the increased incidence of thyroid nodules in females.[8]

The present study demonstrated that Bethesda Category II (Benign) was the most common cytological diagnosis (60%), while non-diagnostic aspirates accounted for only 3.6% of cases. The low inadequacy rate reflects the advantage of ultrasound guidance in obtaining representative samples from small, deep-seated, cystic, or heterogeneous nodules. Similar findings were reported by Trimboli et al., who, in their systematic review, showed that ultrasound-guided FNAC significantly improves specimen adequacy and overall diagnostic performance compared with palpation-guided aspiration.[9]

Histopathological correlation available in operated cases showed a 94.1% concordance between cytological and histopathological diagnoses. Ultrasound-guided FNAC demonstrated a sensitivity of 93.3%, specificity of 97.1%, and an overall diagnostic accuracy of 95.6%. These findings are comparable to those reported by Rosario and Calsolari, who demonstrated excellent sensitivity and specificity of ultrasound-guided FNAC and concluded that real-time ultrasound guidance substantially reduces false-negative and inadequate aspirates.[10]

Suspicious ultrasonographic features such as microcalcifications, irregular margins, hypoechogenicity, and increased intranodular vascularity showed a significant association with malignant cytological diagnoses in the present study. Similar observations were made by Yoon et al., who reported that nodules exhibiting these sonographic characteristics are associated with a substantially higher risk of malignancy and should be prioritized for ultrasound-guided aspiration. They also emphasized the need for ultrasound risk stratification system incorporation to enhance management of the patient by FNAC.[11]

Most of the malignant lesions in this study were found in Bethesda Categories V and VI, with high agreement with the histopathology diagnosis. Jo et al. also documented that the risk of malignancy was also greater in the higher Bethesda categories with Bethesda Category V and VI being the most worrisome to support the predictive value of this classification for clinical decision making.[12]

The cyto-histopathological agreement obtained in this study was very good, providing further support for the reproducibility and reliability of Bethesda reporting system. The Bethesda System's interobserver reproducibility was illustrated and the level of diagnostic concordance was high, showing the importance of reporting uniformity and better communication between clinicians and cytopathologists and proper therapeutic planning, as demonstrated by Bhasin et al.[13]

The final diagnosis of thyroid malignancy and classification of the tumor subtypes was still considered the gold standard diagnosis. This report summarizes the revised diagnostic criteria for the classification of thyroid benign and malignant neoplasms, as established by the WHO Classification of Thyroid Tumours (2022), and along with histopathology helps to integrate the results of these two techniques for proper diagnosis and management. Based on the present findings, the author is reiterating the previous recommendations, and ultrasound guided FNAC is still the main investigation for diagnosis of thyroid nodule.

In conclusion, the results obtained in the present work showed that ultrasound-guided FNAC is a very reliable, safe and less invasive diagnostic tool, which has a very good specimen adequacy and a very good diagnostic accuracy. This risk stratification combined with Bethesda cytological reporting improves the pre-operative evaluation, decreases unnecessary thyroid surgery and aids in early diagnosis of thyroid malignancy.

Conclusion

Fine needle aspiration cytology is a very useful and accurate tool to use in assessing thyroid nodules when guided by ultrasound. The present study showed good specimen adequacy, high

sensitivity, specificity and diagnostic accuracy with a good cyto-histopathological correlation. Non-diagnostic aspirates were substantially decreased and sampling of suspicious nodules was enhanced using ultrasound guidance. Malignant cytology was significantly related to the presence of microcalcifications, irregular margins, hypoechogenicity, and increased vascularity by sonography. The use of the Bethesda System in combination with ultrasound risk stratification offers accurate preoperative diagnosis for all cases and allows for appropriate treatment, while reducing thyroid unnecessary surgery and early detection of thyroid malignancy.

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Conflicts of interest
There are no conflicts of interest.

References
1. Haugen BR, Alexander EK, Bible KC, Doherty GM, Mandel SJ, Nikiforov YE, et al. 2015 American Thyroid Association Management Guidelines for Adult Patients with Thyroid Nodules and Differentiated Thyroid Cancer. Thyroid. 2016;26(1):1-133. doi:10.1089/thy.2015.0020.
2. Cibas ES, Ali SZ. The Bethesda System for Reporting Thyroid Cytopathology. 2nd ed. Cham: Springer Nature; 2018.
3. Ali SZ, Cibas ES, editors. The Bethesda System for Reporting Thyroid Cytopathology: Definitions, Criteria and Explanatory Notes. 2nd ed. Cham: Springer; 2018.
4. Gharib H, Papini E, Garber JR, Duick DS, Harrell RM, Hegedüs L, et al. American Association of Clinical Endocrinologists, American College of Endocrinology, and Associazione Medici Endocrinologi Guidelines for Clinical Practice for the Diagnosis and Management of Thyroid Nodules—2016 Update. Endocr Pract. 2016;22(5):622-639. doi:10.4158/EP161208.GL.
5. Tessler FN, Middleton WD, Grant EG, Hoang JK, Berland LL, Teefey SA, et al. ACR Thyroid Imaging Reporting and Data System (ACR TI-RADS): White Paper of the ACR TI-RADS Committee. J Am Coll Radiol. 2017;14(5):587-595. doi:10.1016/j.jacr.2017.01.046.
6. Russ G, Bonnema SJ, Erdogan MF, Durante C, Ngu R, Leenhardt L. European Thyroid Association Guidelines for Ultrasound Malignancy Risk Stratification of Thyroid Nodules in Adults (EU-TIRADS). Eur Thyroid J. 2017;6(5):225-237. doi:10.1159/000478927.
7. Bongiovanni M, Spitale A, Faquin WC, Mazzucchelli L, Baloch ZW. The Bethesda System for Reporting Thyroid Cytopathology: A meta-analysis. Acta Cytol. 2012;56(4):333-339. doi:10.1159/000339959.
8. Poller DN, Bongiovanni M. Thyroid fine-needle aspiration cytology: Current practice and future developments. Cytopathology. 2020;31(1):4-11. doi:10.1111/cyt.12786.
9. Trimboli P, Nasrollah N, Guidobaldi L, Taccogna S, Cicciarella Modica DD, Amendola S, et al. Diagnostic accuracy of fine-needle aspiration cytology in thyroid nodules: A systematic review and meta-analysis. Endocrine. 2015;48(3):779-786. doi:10.1007/s12020-014-0426-0.
10. Rosario PW, Calsolari MR. Importance of ultrasound-guided fine-needle aspiration in the evaluation of thyroid nodules. Arch Endocrinol Metab. 2016;60(4):367-373. doi:10.1590/2359-3997000000184.
11. Yoon JH, Kwak JY, Moon HJ, Kim MJ, Kim EK. The role of ultrasound-guided fine-needle aspiration for thyroid nodules according to the ultrasound risk stratification systems. Ultrasonography. 2017;36(4):346-353. doi:10.14366/usg.17018.
12. Jo VY, Stelow EB, Dustin SM, Hanley KZ. Malignancy risk for fine-needle aspiration of thyroid lesions according to the Bethesda System for Reporting Thyroid Cytopathology. Am J Clin Pathol. 2010;134(3):450-456. doi:10.1309/AJCP5N4MTHPAFKDJ.
13. Bhasin TS, Mannan R, Manjari M, Mehra M, Sekhon AK, Chandey M. Reproducibility of the Bethesda System for Reporting Thyroid Cytopathology and cyto-histological correlation. J Clin Diagn Res. 2013;7(6):1057-1062. doi:10.7860/JCDR/2013/5304.3059.
14. World Health Organization. WHO Classification of Tumours Editorial Board. Thyroid Tumours. 5th ed. Lyon: International Agency for Research on Cancer; 2022.