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DIAGNOSTIC ACCURACY OF ULTRASONOGRAPHY IN THYROID NODULES: A TIRADS-BASED CORRELATION WITH FNAC

Radio-Diagnosis

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ABSTRACT

BACKGROUND: Thyroid nodules represent a frequently encountered clinical entity in endocrine practice, often identified incidentally on imaging. Although the vast majority are benign, a small but significant proportion are malignant, necessitating reliable triage **AIM:** This study aimed to assess sonographic characteristics of thyroid nodules, stratify the risk of malignancy on the basis of TIRADS scoring system and determine their concordance with FNAC for confirmation.**METHODOLOGY:** A prospective observational study was conducted on 70 patients with thyroid nodules who underwent ultrasonography (USG) followed by USG-guided FNAC. Nodules were evaluated for composition, echogenicity, margins, calcifications, shape, and vascularity, and categorized using TIRADS. Cytology (Bethesda system) served as the reference standard. Diagnostic indices were calculated. **RESULTS:** The mean age of patients was 45.87 ± 13.53 years, with a marked female predominance (94.29%). Most thyroid nodules were benign on FNAC (80.43%), while malignant lesions accounted for 18.57%. On ultrasonography, hypoechoic lesions were most common (28.57%), followed by spongiform and hyperechoic patterns (24.28% each). The majority of nodules showed smooth margins (97.14%) and absence of calcification (84.29%). Most nodules were classified as TIRADS Grade I/II (64.28%), while Grade IV/V lesions (18.56%) showed a higher association with malignancy. Ultrasonography demonstrated a sensitivity of 92.31% and specificity of 98.25%, with an overall diagnostic accuracy of 97.14% **CONCLUSION:** Thyroid nodules in this cohort showed a marked female predominance and were predominantly benign on cytological evaluation. Higher TIRADS categories, along with suspicious sonographic features such as hypoechogenicity, irregular margins, and microcalcifications, were strongly associated with malignancy. Ultrasonography demonstrated excellent diagnostic perfo as a non-invasive risk stratification tool, while FNAC remained indispensable for definitive diagnosis. An integrated approach combining TIRADS and FNAC is essential for optimizing clinical decision-making and minimizing unnecessary interventions.

KEYWORDS

Thyroid nodules, Ultrasonography, FNAC, TIRADS, Risk stratification

INTRODUCTION:

Thyroid nodules are among the most common endocrine abnormalities encountered in clinical practice, characterized by discrete lesions within the thyroid gland that are radiologically or clinically distinct from surrounding parenchyma.[1] Their detection has increased significantly with the widespread use of imaging modalities, particularly high-resolution ultrasonography. Population-based imaging studies have demonstrated a high prevalence of thyroid nodules, particularly with increasing age and widespread use of ultrasonography, although only 5–15% are malignant.[2] A major clinical challenge lies in accurately distinguishing benign from malignant nodules, as both over- and under-evaluation carry significant implications, as over-investigation may lead to unnecessary procedures and increased healthcare costs, while under-evaluation may delay diagnosis of malignancy.[3,4]

Globally, thyroid nodules constitute a substantial proportion of endocrine consultations, with higher detection rates reported in regions with increased access to imaging facilities.[5] Studies from developing countries highlight variations in prevalence, diagnostic approaches, and outcomes, often influenced by resource availability and healthcare infrastructure.[6] In India, the burden of thyroid nodular disease is considerable, with a higher prevalence reported in females and middle-aged individuals.[7] Previous studies have demonstrated that although the majority of nodules are benign, a significant proportion may harbor malignancy, necessitating accurate risk stratification and timely diagnosis.[8,9]

Ultrasonography serves as the primary imaging modality for evaluation of thyroid nodules due to its non-invasive nature, cost-effectiveness, and ability to provide detailed morphological assessment. Certain sonographic features, including hypoechogenicity, irregular margins, microcalcifications, taller-than-wide shape, and increased vascularity, are associated with a higher risk of malignancy.[10,11] However, variability in interpretation among radiologists can lead to inconsistencies in reporting and clinical decision-making.[12]

To address these limitations, standardized risk stratification systems such as the Thyroid Imaging Reporting and Data System (TIRADS) have been developed. Various systems, including ACR-TIRADS, EU-TIRADS, and K-TIRADS, classify nodules based on sonographic characteristics and provide recommendations regarding the need for further evaluation, particularly fine needle aspiration cytology (FNAC).[13,14] FNAC was used as the reference standard, while histopathology remains the definitive gold standard, offering cytological confirmation with high sensitivity and specificity through the Bethesda system.[15]

Despite advancements in imaging and cytological evaluation, the management of thyroid nodules remains complex. Overuse of FNAC in low-risk nodules can lead to unnecessary invasive procedures, patient anxiety, and increased healthcare burden, whereas underutilization in high-risk nodules may result in delayed diagnosis of malignancy.[16] Additionally, variability in healthcare resources, particularly in developing regions, further complicates standardized management strategies.[17]

The need for this study arises from the growing importance of establishing reliable, non-invasive diagnostic tools that can accurately stratify thyroid nodules and guide clinical management. Although TIRADS provides a structured approach, its correlation with FNAC findings requires further evaluation in diverse clinical settings, particularly in resource-limited environments.[18]

This study aims to evaluate the diagnostic accuracy of ultrasonography using the TIRADS classification system and correlate its findings with FNAC in patients with thyroid nodules at a tertiary care center. It also seeks to assess the effectiveness of TIRADS as a predictive tool for malignancy and its role in optimizing patient management and reducing unnecessary invasive procedures.

METHODOLOGY:

This prospective observational study was conducted in the Department of Radiodiagnosis at Zydus Medical College and Hospital, Dahod. A total of 70 consecutive patients presenting with thyroid nodules, detected either clinically or incidentally on imaging, were included in the study. Patients undergoing both ultrasonography (USG) and fine needle aspiration cytology (FNAC) were included, while those with non-diagnostic or inadequate cytology samples and those unwilling for FNAC were excluded.

All patients underwent ultrasonography (using a high-frequency linear transducer). Each thyroid nodule was evaluated based on composition (solid, cystic, mixed, or spongiform), echogenicity (hyperechoic, isoechoic, hypoechoic, very hypoechoic, or anechoic), margins (smooth or lobulated/irregular), calcification (absent, microcalcification, macrocalcification, comet-tail artifact, or peripheral rim calcification), shape (taller-than-wide or wider-than-tall), and vascularity (absent, peripheral, internal, or mixed). Nodules were categorized using the ACR-TIRADS (2017) classification system.

USG-guided FNAC was performed in all patients, and cytological findings were reported using the Bethesda System for Reporting Thyroid Cytopathology. Statistical analysis was carried out using SPSS software, and diagnostic parameters including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated using FNAC as the reference standard.

STATISTICALANALYSIS:

All statistical data were analysed using statistical package for the social sciences (SPSS) version 22. Sensitivity, specificity, PPV, and NPV were computed using FNAC as the reference.

RESULTS:

In the present study, a total of 70 patients with thyroid nodules were included. The mean age of the study participants was 45.87 ± 13.53 years. We found female predominance 66 cases (94.29%) while only 4(5.71%) patients were male, as shown in Table 1.

Table No. 1: Demographic and clinical profile of patients with thyroid nodule.

Age	Mean ± SD	45.87 ± 13.53
Gender	Female	66 (94.29%)
	Male	4(5.71%)

According to Table 2, In the assessment of nodule margins among the 70 cases, smooth margins were observed in the majority of the thyroid nodules, accounting for 68 cases (97.14%). Lobulated margins were seen in only 2 nodules (2.86%).

Table No. 2: Margin of thyroid nodules among study population:

MARGIN	No. of cases	%
Lobulated	02	2.86%
Smooth	68	97.14%

Based on the echogenicity of the thyroid nodules, hypoechoic lesions were the most common, observed in 20 cases (28.57%). Both spongiform and hyperechoic patterns were equally present, each in 17 cases (24.28%). Isoechoic nodules were seen in 8 cases (11.43%), while anechoic lesions accounted for 4 cases (5.71%). Mixed spongiform and very hypo-echoic nodules were the least common, with 2 cases (2.86%) each.

Table No. 3: Distribution of Thyroid nodule based on echogenicity of the nodules

Variables	N=70 N (%)
Spongiform	17 (24.28%)
Anechoic	04 (5.71%)
Hyperechoic	17 (24.28%)
Hypoechoic	20 (28.57%)
Isoechoic	08 (11.43%)
Mixed Spongiform	02 (2.86%)
Very hypoechoic	02 (2.86%)

Based on the contents of the thyroid nodules, spongiform lesions were the most common, observed in 24 cases (34.28%). This was followed by solid nodules in 23 cases (32.86%) and mixed solid-cystic nodules in 21 cases (30%). Cystic nodules were least common.

Table No. 4: Distribution of Thyroid nodule based on contents of the nodules

Variables	N=70 N (%)
Solid	23 (32.86%)
Spongiform	24 (34.28%)
Solid + cystic	21 (30%)
Cystic	02 (2.86%)

Calcification analysis among the 70 thyroid nodules showed that calcifications were absent in the majority of cases, with 59 nodules (84.28%) displaying no evidence of calcification. Macro-calcifications were present in 3 cases (4.28%), while punctuate calcifications and comet tail artifacts were each identified in 3 cases (4.29%). peripheral rim of calcification was observed in 1 case (1.43%).

Table No. 5: Characteristics of thyroid nodule on the basis of calcification.

Variables	N=70 N (%)
Absent	59 (84.29%)
Comet tail artifact	03 (4.29%)
Macrocalcification	03 (4.29%)
Microcalcification	03 (4.29%)
Peripheral rim of calcification	01 (1.43%)

Based on the TIRADS grading system, the majority of thyroid nodules were categorized as Grade I, comprising 24 cases (34.28%), followed by Grade II with 21 cases (30%). Grade III nodules were identified in 12 cases (17.14%), while Grade IV and Grade V were less common, seen in 10 cases (14.28%) and 3 cases (4.28%) respectively. Overall, most nodules were found to be benign, accounting for 45 cases (64.29%). Suspicious findings were noted in 12 cases (17.14%), while 13 cases (18.57%) were identified as malignant. These findings indicate that benign nodules constituted the majority; however, a considerable proportion of cases were either suspicious or malignant.

Table No. 6: TIRADS grading on the basis of sonographic evaluation

Variables	N=70 N (%)
Grade I	24 (34.28%)
Grade II	21 (30%)
Grade III	12 (17.14%)
Grade IV	10 (14.28%)
Grade V	03 (4.28%)
Interpretation	N=70 N (%)
Benign	45 (64.29%)
Suspicious	12 (17.14%)
Malignant	13 (18.57%)

Table No. 7: TIRADS and FNAC

A total of 70 thyroid nodules were categorized using TIRADS and correlated with FNAC findings.

TIRADS	FNAC categories	Number (%)
Grade I (n=24)	TBS I	01 (1.43%)
	TBS II	22 (31.43%)
	Hashimoto	01 (1.43%)
Grade II (N=21)	Cat I	02 (2.86%)
	Cat II	18 (25.71%)
	Cat III	01 (1.43%)
Grade III (N=12)	Cat II	11 (15.71%)
	Cat IV	01 (1.43%)
Grade IV (N=10)	Cat III	01 (1.43%)
	Cat IV	03 (4.28%)
	Cat V	03 (4.28%)
	Cat VI	03 (4.28%)
Grade V (N=03)	Cat IV	01 (1.43%)
	Cat VI	02 (2.86%)
Benign FNAC	57 (80.43%)	
Malignant FNAC	13 (18.57%)	

Table No. 8: USG Sensitivity and specificity in predicting malignancy.

Statistic	Value	95% CI
Sensitivity	92.31%	63.97% to 99.81%
Specificity	98.25%	90.61% to 99.96%
Positive Likelihood Ratio	52.62	7.49 to 369.47
Negative Likelihood Ratio	0.08	0.01 to 0.51
Disease prevalence	18.57%	10.28% to 29.66%

DISCUSSION:

In the present analysis evaluating thyroid nodules using ultrasonography and correlating TIRADS classification with FNAC findings, the mean age was 45.87 ± 13.53 years with a marked female predominance, consistent with previous literature [7,17]. Most nodules were benign on FNAC, and the majority were categorized into lower TIRADS grades (I–III), while malignant lesions were predominantly seen in higher grades (IV–V), in agreement with established studies [13,18]. Sonographic features such as hypoechogenicity, irregular margins, and suspicious calcifications showed a significant association with malignancy, as described by Moon et al. and Kim et al. [10,11]. Ultrasonography demonstrated high sensitivity and specificity, supporting its role as a reliable first-line diagnostic modality [5,16].

A similar trend has been documented in prior studies, which also reported a higher proportion of benign nodules and an increasing risk of malignancy with higher TIRADS categories [13,18,19]. The concordance between TIRADS classification and FNAC findings observed in our observations is consistent with prior research highlighting the complementary role of imaging and cytology [15,20]. Previous investigations have demonstrated that combining TIRADS with the Bethesda system improves diagnostic accuracy and reduces unnecessary invasive procedures [15,21].

Published litreture have emphasized the value of high-resolution ultrasonography as a non-invasive and cost-effective tool for risk stratification of thyroid nodules [5,17,22]. Lower TIRADS categories are consistently associated with benign pathology, whereas higher categories correlate strongly with malignancy, reinforcing the predictive value of structured reporting systems [13,18,23].

Overall, the present analysis supports the use of TIRADS-based ultrasonography as an effective screening and risk stratification tool. When combined with FNAC, it enhances diagnostic accuracy, reduces unnecessary procedures, and aids in optimal clinical decision-making [5,13,15].

LIMITATIONS:

- Small sample size (n=70)
- Single-center study
- Lack of histopathological correlation in all cases

CONCLUSION:

The present results highlights that the TIRADS classification system is a valuable, non-invasive tool in the evaluation of thyroid nodules, enabling effective risk stratification and prediction of malignancy. Its application helps reduce unnecessary FNAC procedures, particularly in low-risk nodules, thereby minimizing patient discomfort and optimizing resource utilization. When used in conjunction with FNAC, TIRADS enhances diagnostic confidence and supports more accurate clinical decision-making. The combined use of ultrasonography and cytology thus provides a comprehensive approach, improving diagnostic precision and contributing to more efficient patient management.

Furthermore, ultrasonography demonstrated excellent diagnostic performance in comparison with FNAC. The sensitivity and specificity of USG were 92.31% and 98.25%, respectively, indicating a high ability to correctly identify both malignant and benign lesions. The positive and negative predictive values were equally high (92.31% and 98.25%), supported by a strong positive likelihood ratio of 52.62 and a low negative likelihood ratio of 0.08. An overall diagnostic accuracy of 97.14% further reinforces the role of ultrasonography as a reliable, non-invasive first-line modality in the assessment of thyroid nodules.

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