Section: Radiodiagnosis

Original Research Article

CORRELATION OF THYROID IMAGING REPORTING AND DATA SYSTEM (TI-RADS) WITH PATHOLOGICAL FINDINGS IN EVALUATION OF THYROID NODULE

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Abstract

Background: The aim of the study on the correlation of TI-RADS with pathological findings in evaluation of thyroid nodules to assess the accuracy and reliability of TI-RADS in predicting the malignancy of thyroid nodules detected through imaging. **Materials and Methods:** This cross-sectional study involved 100 cases at the Department of Radiodiagnosis, BRD Medical College, Gorakhpur, using a Philips Affinity 70 Ultrasound system. Patients referred from the Department of Otorhinolaryngology were included based on specific criteria, with FNA conducted on nodules with suspicious ultrasound features. Statistical analyses included chi-square tests, t-tests, and logistic regression to compare categorical and continuous variables. **Result:** Of 100 study participants, 79% (n = 79) were females, and the mean age was 39.1 ± 12.1 years. Majority of thyroid nodules (44%, n = 44) were solid or almost solid, 94% (n = 94) were shaped wider than tall, 84% (n = 84) had smooth margins, 71% (n = 71) were hyperechoic or isoechoic, and 75% (n = 75) had no echogenic foci. TI-RADS 3 was the most common at 41% (n = 41). The proportions of malignancy for TI-RADS 4 and TI-RADS 5 were 77% and 83%, respectively. The correlation between ACR TI-RADS and the Bethesda system of thyroid classification scores was roc ~ 0.88. The sensitivity, specificity, positive and negative predictive values, and positive and negative likelihood ratios of ACR TI-RADS were 92%, 96%, 80%, 98%, 23, and 0.083, respectively. **Conclusion:** In our study we found that the ACR TI-RADS classification is appropriate and also non invasive method for assessing thyroid nodule in the routine practice. TI-RADS can safely reduce numbers of unnecessary FNA in a significant proportion of benign thyroid lesions. Thyroid nodules which are classified as TI-RADS 3 and should be followed up routinely. ACR TI-RADS should be standardized as the screening tool in resource-limited areas.

INTRODUCTION

Thyroid nodules are a prevalent thyroid disorder globally, with detection rates varying depending on the method of examination. Palpation typically yields a prevalence range of 4–7%, whereas sonography can detect nodules in 19–68% of cases. Autopsy findings indicate a prevalence of 8–65% through pathologic examination. This increased detection, 1 particularly through high-resolution ultrasound, has led to the identification of subclinical nodules, contributing to the higher prevalence rates. Thyroid nodules are predominantly benign, with malignancy detected in less than 5–10% of cases. However, there are regional variations in the prevalence of benign versus malignant nodules. Differentiating between benign and malignant thyroid nodules is vital in clinical practice as it directs appropriate treatment strategies.[1,2]

A study conducted at Mulago National Referral Hospital revealed that among evaluated thyroid nodules, 5% were malignant, 25% were suspicious, and 70% were benign. These findings underscore the importance of developing effective tools for assessing malignancy risk in patients with thyroid nodules.[3]

The need for reliable risk assessment tools is critical in clinical practice to guide further evaluation and management decisions for patients with thyroid nodules.[4] By accurately identifying nodules with malignant potential, healthcare professionals can optimize patient care and outcomes through timely intervention and treatment strategies. Differentiating between benign and malignant thyroid nodules is vital in clinical practice as it directs appropriate treatment strategies.[5]

Ultrasound imaging serves as a primary tool in this differentiation process, relying on specific nodule characteristics for assessment. The Thyroid Imaging Reporting and Data System (TI-RADS) was introduced to enhance the accuracy of ultrasound evaluations by considering various features of the nodules. The American College of Radiology Thyroid Imaging Reporting and Data Systems (ACR TI-RADS) employs a systematic approach, 5-point classification system is used to assess the cancer risk in thyroid nodules by analyzing their ultrasound features. These characteristics include the nodule's composition, echogenicity, shape, margin, and presence of echogenic foci. Each nodule is assigned a total score, ranging from TI-RADS 1 (benign) to TI-RADS 5 (highly suspicious), [6] aiding clinicians in making informed decisions regarding further management.

The incidence of thyroid nodules shows a significant gender disparity, with women being reported to have a prevalence four times higher than men. Over the past two decades, controversies have emerged regarding the malignant characteristics of thyroid nodules, yet a definitive classification system has not been established. TI-RADS offers a promising approach to enhance the consistency and accuracy of thyroid nodule assessment. Continued research and collaboration in this area are essential to refine and optimize the utility of TI-RADS in clinical practice.[6,7]

MATERIALS AND METHODS

It was a cross sectional study conducted in Department of Radio-diagnosis, BRD medical college, Gorakhpur, Uttar Pradesh in India for a period of One Year ((June 2023 – May 2024). Approval of ethical clearance was obtained from Institution Ethical Committee, BRD Medical College, Gorakhpur.

Inclusion Criteria

- Individuals of both genders referred from the Department of Otorhinolaryngology (ENT) for evaluation of thyroid lesions.
- Age between 18 to 65 years
- Patients having thyroid nodule on ultrasonography.

Exclusion Criteria

- Patients without any thyroid nodule on ultrasonography.
- Individuals with known thyroid cancer.
- Nodule size < 5mm in size.
- Individuals with a history of neck surgery or radiation therapy.
- Individuals with known bleeding diathesis.

The sample size was determined using Kish Leslie's formula.

$N=Z^2$ x $p(1-p)/d^2$ where:

N = sample size.

Z = Z score ~ 0.96 for 95% confidence level.

P= the proportion of individuals in the population with characteristic of interest. d = margin of error, which is 0.05

Taking the prevalence (clinically) of thyroid nodules as 7 %, we obtained sample size of 100 individuals.

Thyroid gland disorders encompassed benign and malignant thyroid nodules as well as diffuse thyroid disorders. For all patients, the ultrasound examination began with B-mode imaging and prior to examination, patients were positioned to supine with neck slightly extended over the pillow. For focal or diffuse lesions of the thyroid gland, the examination was conducted by placing the transducer (eL18-4 MHz probe) over the area of thyroid gland. Patients which were having thyroid nodule in B-mode ultrasound went for (FNAC) . Bethesda classification of these nodules were tabulated. finally using the accuracy, positive predictive value (PPV), negative predictive value (NPV).

RESULTS

Table 1: Socio-demographic Characteristics of Study Population.

Variables	Frequency (N) = 100	Percentage (%)	p-value
Gender			
Male	21	21.0%	<0.001
Female	79	79.0%	
Age Group (Years)	(95% CI: 36.7-41.5)		
<20	3	3.0%	<0.001
20-40	63	63.0%	
40-60	25	25.0%	
≥60	9	9.0%	
Mean ± SD	39.1 ± 12.1		
Demography			
Rural	79	79.0%	<0.001
Urban	21	21.0%	

The [Table 1] presents demographic and age group distributions among a cohort of 100 individuals, with data on gender, age, and rural-urban demography, along with their respective frequencies and percentages. The gender distribution shows that 21.0% (21 individuals) are male, while a significant majority, 79.0% (79 individuals), are female. The p-value of less than 0.001 indicates statistically significant difference in gender distribution, suggesting a pronounced incline towards females in this cohort.

Table 2: Sonographic appearance of thyroid nodules based on ACR TIRADS

Characteristic	Type	Frequency (N) = 100	Percentage (%)	P-value
Composition	Cystic	15	15.0%	<0.001
	Mixed	38	38.0%	
	Solid	44	44.0%	
	Spongiform	3	3.0%	
Shape	Wider than tall	94	94.0%	
	Taller than wider	6	6.0%	
Echogenicity	Anechoic	15	15.0%	
	Hyper	34	34.0%	
	Very hypo	3	3.0%	
	Hypo	11	11.0%	
	Iso	37	37.0%	
Margin	Smooth	84	84.0%	
	Lobulated	11	11.0%	
	Extrathyroid extension	2	2.0%	
	Ill defined	3	3.0%	
Echogenic foci/ calcification	Large comet tail artifact	4	4.0%	
	None	75	75.0%	
	Punctate	6	6.0%	
	Macrocalcification	9	9.0%	
	Peripheral rim of calcification	6	6.0%	

[Table 2] presents the distribution of various thyroid nodule characteristics among a sample of 100 patients. In terms of composition, solid nodules are the most prevalent, constituting 44.0% of the cases, followed by mixed (38.0%), cystic (15.0%), and spongiform nodules (3.0%), with significant variation ($p < 0.001$). Regarding shape, the majority of nodules are wider than tall (94.0%), while only 6.0% are taller than wider. Echogenicity assessment shows that iso-echogenic nodules are the most common (37.0%), followed by hyper-echogenic nodules (34.0%), anechoic (15.0%), hypo-echogenic (11.0%), and very hypo-echogenic (3.0%), indicating a wide range of echogenic properties. The margin characteristics reveal that most nodules have smooth margins (84.0%), with fewer showing lobulated (11.0%), extrathyroid extension (2.0%), or ill-defined margins (3.0%). Lastly, the echogenic foci/calcifications indicate that 75.0% of nodules show no echogenic foci, while 9.0% exhibit macrocalcifications, 6.0% punctate calcifications, 6.0% peripheral rim of calcification, and 4.0% large comet tail artifacts, reflecting the variety in echogenic features. The p-values highlight significant associations with nodule composition, emphasizing the importance of these characteristics in diagnostic assessments.

Table 3: Correlation of ACR TIRADS and Bethesda system of thyroid classification

	BETHESDA system of classification						
ACR TIRADS categorization	**2**	**3**	**4**	**5**	**6**	**Total N (%)**	**ROM**
TIRADS 1	8	0	0	0	0	8 (8.0 %)	0 %
TIRADS 2	36	0	0	0	0	36 (36.0%)	0 %
TIRADS 3	40	0	1	0	0	41 (41.0%)	2.4 %
TIRADS 4	2	0	2	5	0	9 (9.0 %)	77 %
TIRADS 5	1	0	0	0	5	6 (6.0 %)	83 %
Total N (%)	87 (87.00%)	0 (0.0 %)	3 (3.00 %)	5 (5.00 %)	5 (5.00 %)	100 (100.0%)	

[Table 3] presents a classification of nodules based on the American College of Radiology Thyroid Imaging Reporting and Data System (ACR TIRADS) and the BETHESDA system. In TIRADS 1, all 8 cases (8.00% of the total) were classified under BETHESDA category 2. For TIRADS 2, all 36 cases (36.00%) were categorized as BETHESDA 2. TIRADS 3 encompasses 41 cases (41.00%), with the majority (40 cases) in BETHESDA 2 and 1 case in BETHESDA 4. TIRADS 4 includes 9 cases (9.00%), distributed as 2 cases in BETHESDA 2, 2 cases in BETHESDA 4, and 5 cases in BETHESDA 5. TIRADS 5 comprises 6 cases (6.00%), with 1 case in BETHESDA 2 and 5 cases in BETHESDA 6. Overall, the distribution shows that 87% of nodules fall under BETHESDA category 2, indicating a predominant benign nature. The remaining categories (BETHESDA 3, 4, 5, and 6) collectively account for 13%, with malignancy risk increasing from BETHESDA 4 to 6. This categorization underscores the importance of TIRADS and BETHESDA systems in stratifying thyroid nodules by risk, facilitating clinical decision-making regarding further diagnostic and therapeutic interventions.

Table 4: Sensitivity of TIRADS

Sensitivity of TIRADS	Value (%)
Sensitivity	92
Specificity	96
Positive Predictive Value (PPV)	80
Negative Predictive Value (NPV)	98

[Table 4] provides data on the diagnostic performance of the TIRADS system in distinguishing between malignant (M) and benign (B) thyroid nodules. It shows that TIRADS correctly identified 12 malignant nodules (true positives) and 84 benign nodules (true negatives), while misclassifying 3 benign nodules as malignant (false positives) and 1 malignant nodule as benign (false negatives). The sensitivity of TIRADS, calculated as the ratio of true positives to the sum of true positives and false negatives, is 92%, indicating high effectiveness in detecting malignant nodules. The specificity, calculated as the ratio of true negatives to the sum of true negatives and false positives, is 96%, reflecting high accuracy in identifying benign nodules. The positive predictive value (PPV), representing the proportion of nodules identified as malignant that are actually malignant, is 80%, while the negative predictive value (NPV), representing the proportion of nodules identified as benign that are actually benign, is 98%. These metrics collectively demonstrate the robustness of the TIRADS system in accurately diagnosing thyroid nodules, underscoring its utility in clinical practice.

Table 5: Distribution of study subjects by diagnosis

Diagnosis	Frequency (N) = 100	Percentage (%)	P-value
Colloid goitre	17	17.00%	<0.001
Colloid goitre with cystic degeneration	16	16.00%	
Medullary thyroid carcinoma	3	3.00%	
Lymphocytic thyroiditis	7	7.00%	
Oncocytic carcinoma	2	2.00%	
Follicular neoplasm	3	3.00%	
Benign follicular nodule	12	12.00%	
Follicular adenoma	2	2.00%	
Nodular goitre	16	16.00%	
Thyroid lymphoma	1	1.00%	
Oncocytic adenoma	1	1.00%	
Autoimmune thyroiditis	7	7.00%	
Papillary hyperplasia	7	7.00%	
Anaplastic thyroid carcinoma	1	1.00%	
Hashimoto's thyroiditis	5	5.00%	

[Table 5] summarizes the distribution of various thyroid diagnoses among a sample of 100 patients, highlighting the frequency and percentage of each condition along with the associated p-values. Colloid goitre emerges as the most prevalent diagnosis, observed in 17% of cases, with a statistically significant p-value of less than 0.001, suggesting a notable predominance. Colloid goitre with cystic degeneration and nodular goitre each account for 16% of the cases, indicating their common occurrence. Benign follicular nodules are present in 12% of the sample. Conditions such as lymphocytic thyroiditis, autoimmune thyroiditis, and papillary hyperplasia are each observed in 7% of patients. Hashimoto's thyroiditis appears in 5% of the cases. Less frequent diagnoses include medullary thyroid carcinoma and follicular neoplasm, each at 3%, and oncocytic carcinoma and follicular adenoma, each at 2%. Rare diagnoses such as thyroid lymphoma, oncocytic adenoma, and anaplastic thyroid carcinoma are each found in 1% of the patients.

Table 6: Distribution of TIRADS based on Benign and malignant

TIRADS	Benign	Malignant	p-value
1	8 (8.0%)	0 (0.0%)	<0.001
2	36 (36.0%)	0 (0.0%)	
3	40 (40.0%)	1 (1.0%)	
4	2 (2.0%)	7 (7.0%)	
5	1 (1.0%)	5 (5.0%)	

[Table 6] categorizes thyroid nodules based on the TIRADS system, differentiating between benign and malignant cases. TIRADS 1 shows that 8% of the nodules are benign with no malignant cases, supported by a statistically significant p-value of < 0.001, indicating a strong correlation with benignity. TIRADS 2 includes 36% benign nodules, with no malignancies, further reinforcing its reliability in identifying non-malignant nodules. In TIRADS 3, 40% of the nodules are benign, with a minimal 1% being malignant, suggesting a predominance of benign cases even in this category. TIRADS 4 presents a higher malignancy risk, with 2% benign and 7% malignant nodules, reflecting the increasing risk as the TIRADS level rises. TIRADS 5 is most strongly associated with malignancy, with 1% benign and 5% malignant nodules, highlighting its significant correlation with malignant cases. Overall, the TIRADS system effectively stratifies thyroid nodules by malignancy risk, aiding in clinical decision-making and management.

Table 7: Distribution of BETHESDA based on Benign and malignant

BETHESDA	Benign	Malignant	p-value
2	87 (87.0%)	0 (0.0%)	<0.001
3	0 (0.0%)	0 (0.0%)	
4	0 (0.0%)	3 (3.0%)	
5	0 (0.0%)	5 (5.0%)	
6	0 (0.0%)	5 (5.0%)	

[Table 7] classifies thyroid nodules according to the BETHESDA system, distinguishing between benign and malignant cases, and includes their respective percentages and p values. BETHESDA category 2, representing 87% of the cases, is exclusively associated with benign nodules, with a highly significant p-value of < 0.001, indicating a strong correlation with benignity. No cases fall under BETHESDA category 3, neither benign nor malignant. In BETHESDA category 4, 3% of the nodules are malignant, highlighting a risk of malignancy within this category. BETHESDA category 5 and 6 comprises 5% of the nodules, all of which are malignant. These distributions underscore the effectiveness of the BETHESDA system in stratifying thyroid nodules by their malignancy risk.

Figure 1: TR1 Nodule

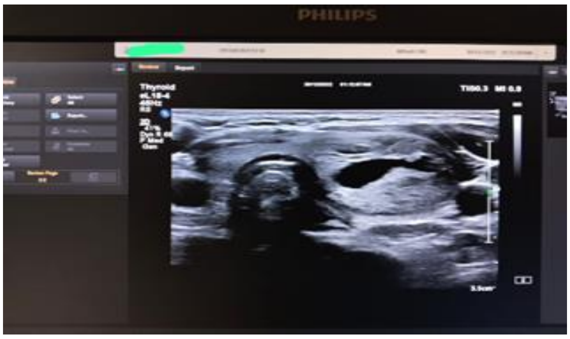

Figure 2: TR2 nodule

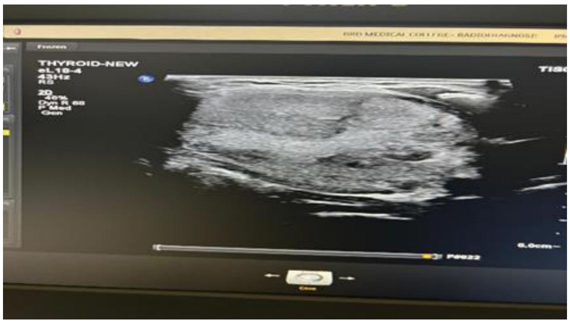

Figure 3: TR3 nodule

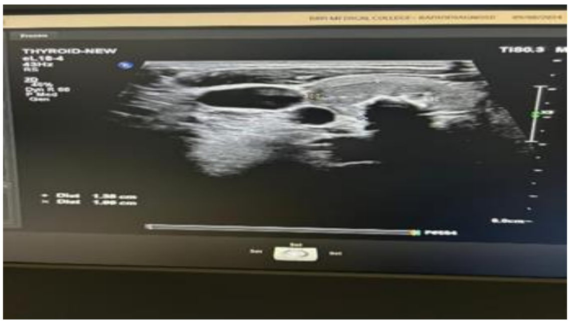

Figure 4: TR 4 nodule

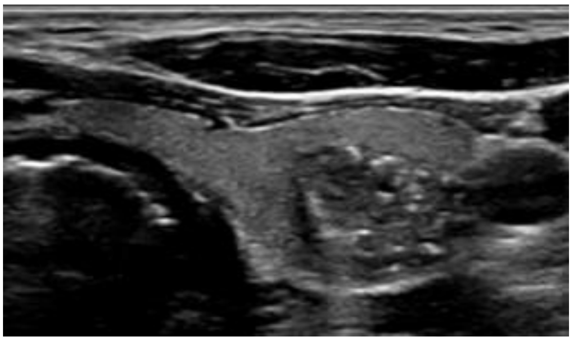

Figure 5: TR 5 nodule

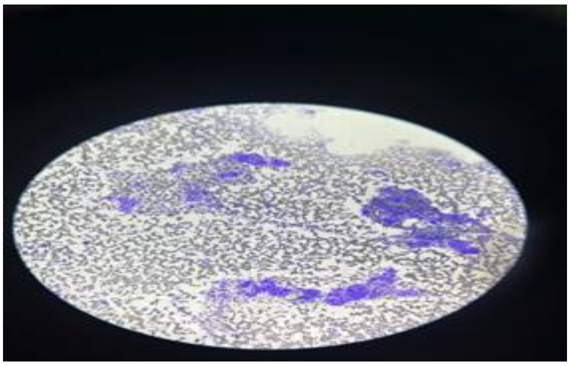

Figure 6: colloid nodule with cystic degeneration (Bethesda II)

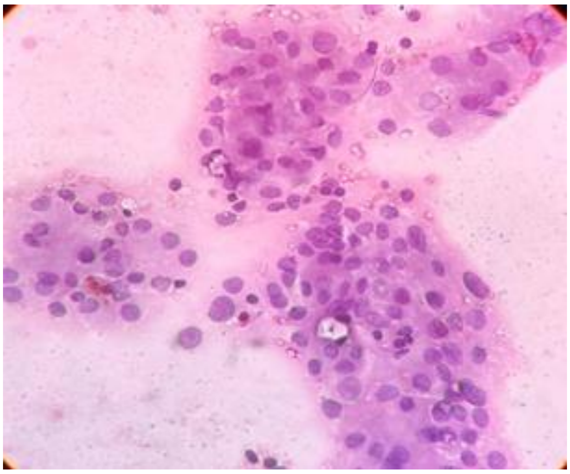

Figure 7: Lymphocytic Thyroiditis (Bethesda II)

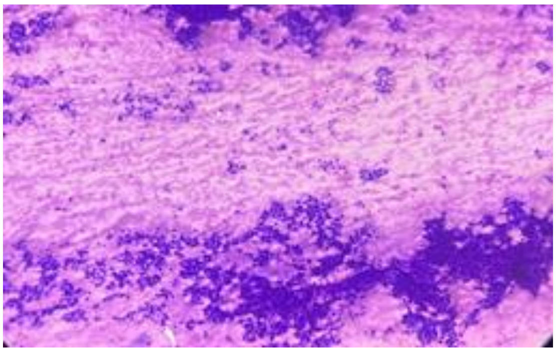

Figure 8: follicular neoplasm (Bethesda CAT IV)

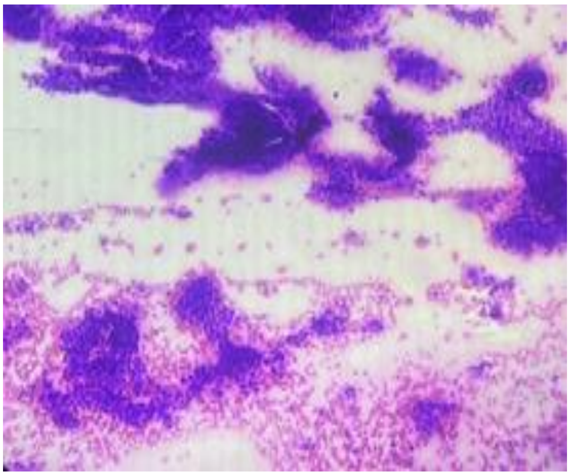

Figure 9: papillary carcinoma – (bethesda cat VI)

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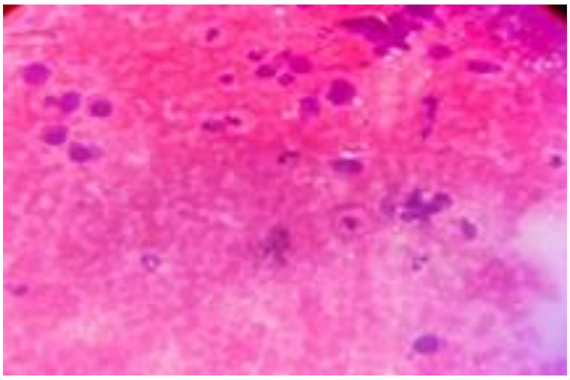

Figure 10: Medullary carcinoma (bethesda cat VI)

Table 8: Distribution of Composition by TIRADS Categories

TIRADS	Cystic	Mixed	Solid	Spongiform	p-value
1	5 (5.0%)	0 (0.0%)	0 (0.0%)	3 (3.0%)	<0.001
2	10 (10.0%)	26 (26.0%)	0 (0.0%)	0 (0.0%)	
3	0 (0.0%)	10 (10.0%)	31 (31.0%)	0 (0.0%)	
4	0 (0.0%)	1 (1.0%)	8 (8.0%)	0 (0.0%)	
5	0 (0.0%)	1 (1.0%)	5 (5.0%)	0 (0.0%)	
% of Total	15.00 %	38.00 %	44.00 %	3.00%	100.0 %

[Table 8] categorizes thyroid nodules based on their composition (cystic, mixed, solid, spongiform) and their corresponding TIRADS classification, alongside p-values. For TIRADS 1, 5% of nodules are cystic and 3% are spongiform, with no mixed or solid nodules, and a significant p-value of < 0.001, indicating a strong association with these compositions. In TIRADS 2, 10% of nodules are cystic, 26% are mixed, while there are no solid or spongiform nodules. TIRADS 3 shows a distribution where 10% are mixed and 31% are solid, without cystic or spongiform nodules. TIRADS 4 includes 1% mixed and 8% solid nodules, with no cystic or spongiform nodules. For TIRADS 5, 1% are mixed and 5% are solid, also without cystic or spongiform nodules. Overall, the distribution of nodules across all TIRADS categories is 15% cystic, 38% mixed, 44% solid, and 3% spongiform.

Table 9: Distribution of Margin by TIRADS Categories

TIRADS	Smooth	Lobulated	Extrathyroid Extension	Ill Defined	p-value
1	8 (8.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	<0.001
2	29 (29.0%)	5 (5.0%)	0 (0.0%)	2 (2.0%)	
3	40 (40.0%)	0 (0.0%)	0 (0.0%)	1 (1.0%)	
4	6 (6.0%)	3 (3.0%)	0 (0.0%)	0 (0.0%)	
5	1 (1.0%)	3 (3.0%)	2 (2.0%)	0 (0.0%)	
% of Total	84.00%	11.00%	2.00%	3.00%	100%

Table 10: Distribution of Echogenic Foci/Calcification by TIRADS Categories

TIRADS	Large Comet Tail Artifact	None	Punctate	Macrocalcification	Peripheral Rim of Calcification	p-value
1	4 (4.0%)	4 (4.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	<0.001
2	0 (0.0%)	31 (31.0%)	0 (0.0%)	0 (0.0%)	5 (5.0%)	
3	0 (0.0%)	34 (34.0%)	0 (0.0%)	7 (7.0%)	0 (0.0%)	
4	0 (0.0%)	5 (5.0%)	1 (1.0%)	2 (2.0%)	1 (1.0%)	
5	0 (0.0%)	1 (1.0%)	5 (5.0%)	0 (0.0%)	0 (0.0%)	
% of Total	4.00%	75.00%	6.00%	9.00%	6.00%	100%

[Table 9] provides an in-depth analysis of thyroid nodule margins categorized by TIRADS scores, highlighting the percentage distribution of nodules with smooth, lobulated, extra thyroid extension, and ill-defined margins. In TIRADS 1, 8% of nodules have smooth margins, with no lobulated, extrathyroid extension, or ill-defined margins observed. For TIRADS 2, 29% have smooth margins, 5% are lobulated, and 2% are ill-defined, with no extrathyroid extension. In TIRADS 3, a significant 40% of nodules exhibit smooth margins, with only 1% having ill-defined margins and none showing lobulated or extrathyroid extension. TIRADS 4 reveals 6% with smooth margins and 3% lobulated, with no other types present. TIRADS 5 shows a more diverse distribution: 1% smooth, 3% lobulated, and 2% with extrathyroid extension, without any ill-defined margins. The overall percentages across all TIRADS categories are: 84% smooth, 11% lobulated, 2% with extrathyroid extension, and 3% ill-defined. The p-value of < 0.001 indicates a highly significant association between TIRADS categories and nodule margin types. This association emphasizes the importance of detailed margin analysis in the assessment and treatment of thyroid nodules.

[Table 10] presents a detailed analysis of echogenic foci or calcification types in thyroid nodules categorized by TIRADS (Thyroid Imaging Reporting and Data System) scores. Specifically, in TIRADS 1, 4% of nodules exhibit a large comet tail artifact, and 4% have no echogenic foci. In TIRADS 2, 31% of nodules lack echogenic foci, and 5% show a peripheral rim of calcification. TIRADS 3 is notable for 34% of nodules with no echogenic foci and 7% displaying macrocalcification. For TIRADS 4, the distribution includes 5% with no echogenic foci, 1% with punctate calcifications, 2% with macrocalcifications, and 1% with a peripheral rim of calcification. In TIRADS 5, 1% of nodules have no echogenic foci and 5% have punctate calcifications. Overall, the percentages of each echogenic focus type across all categories are: 4% large comet tail artifact, 75% with no echogenic foci, 6% punctate, 9% macrocalcifications, and 6% with a peripheral rim of calcification. The p-value of <0.001 indicates a highly significant association between TIRADS categories and types of echogenic foci or calcification. This significance highlights the critical role of echogenic foci in the diagnostic evaluation and risk assessment in thyroid nodule management.

DISCUSSION

The present study found that the socio-demographic characteristics of the study population, comprising 100 individuals, exhibited significant trends in gender, age, and rural-urban distribution. Specifically, the gender distribution revealed a pronounced female predominance, with 79.0% of the cohort being female compared to 21.0% male, a difference that was statistically significant ($p < 0.001$). The findings of the present study regarding gender distribution align with those of isse et al[8] who also reported a significant female predominance in their study on thyroid nodules, with 90.0% of their 132 participants being female and 10.0% male. However, dy et al,[9] observed a slightly older mean age of 46.9 years in their study of 149 patients, with the majority falling within the 40-60 years age group (dy et al., 2022) possibly including older patients or those with more advanced thyroid conditions.
The margin characteristics of the nodules showed that the vast majority (84.0%) had smooth margins, while smaller proportions exhibited lobulated margins (11.0%), extrathyroid extension (2.0%), or ill-defined margins (3.0%). The findings of the present study regarding the composition of thyroid nodules align closely with those reported by isse et al,[8] who also found a predominance of solid nodules in their study of 132 thyroid nodules, with 54.7% being solid and 36.0% mixed. In contrast, the study by dy et al,[9] observed a slightly different distribution, with a higher proportion of solid nodules (62.0%) and a lower proportion of mixed nodules (37.0%) among their 149 patients. Finally, the findings on nodule margins and echogenic foci in the present study align with those of dy et al,[9] who also observed that the majority of nodules had smooth margins (60.0%) and lacked echogenic foci (84.0%) in their cohort of 149 patients (dy et al). The result of the present study are consistent with those reported by isse et al,[8] who also explored the correlation between the TIRADS and Bethesda systems in their study of 132 thyroid nodules. isse et al. found that the majority of nodules classified under TIRADS 1 and 2 were benign, corresponding to Bethesda category 2, similar to the current study where 100% of nodules in TIRADS 1 and 2 were benign. Sahli et al,[10] also conducted a study that examined the correlation between TIRADS classification and Bethesda system categories among indeterminate thyroid nodules. The present study found that the TIRADS system demonstrated strong diagnostic performance in distinguishing between malignant and benign thyroid nodules, as evidenced by its high sensitivity, specificity, and predictive values. Lymphocytic thyroiditis, autoimmune thyroiditis, and papillary hyperplasia were each diagnosed in 7% of patients, indicating a moderate prevalence of these inflammatory and hyperplastic conditions. Sahli et al. [10], who found that Bethesda categories 2 and 6 were strongly associated with benign and malignant outcomes, respectively (Sahli et al., 2019). In their study, 85% of nodules in Bethesda 2 were benign, while 90% of those in Bethesda 6 were malignant, closely mirroring the distributions observed in the current study.
These findings underscore the reliability and sensitivity of the diagnostic test in correctly identifying the health status of individuals within the sample population, with a strong bias towards accurate disease detection. Additionally, et al,[11] (2023) examined the correlation between ACR TI-RADS and fine-needle aspiration cytology in a Ugandan population. Out of 132 patients, 22 were diagnosed as diseased, and 110 as healthy. TIRADS 1 nodules had exclusively smooth margins. Regarding margin characteristics, the current study's findings are consistent with those of isse et al,[8] who also found that smooth margins were predominant in lower TIRADS categories, particularly in TIRADS 1 and 2. Their study reported that 80% of nodules in TIRADS 1-2 had smooth margins, closely aligning with the 84% observed in the present study.
In TIRADS 4, nodules were distributed across different calcification types: 5% had no echogenic foci, 1% had punctate calcifications, 2% had macro calcifications, and 1% had a peripheral rim of calcification. In TIRADS 5, 1% of nodules had no echogenic foci, while 5% had punctate calcifications. The findings on echogenic foci and calcifications in the present study align with those reported by isse et al,[8] who also observed a strong association between the presence of calcifications and higher TIRADS categories.
Additionally, the positive likelihood ratio was 23, underscoring the test's strong capacity to confirm disease presence when the result was positive, while the negative likelihood ratio was 0.083, suggesting a very low probability of the disease in patients with a negative test result. Similarly, the study by richa et al. [13] (2020) found that the sensitivity and specificity of their TI-RADS system ranged from 92% to 90% and 60% to 98%, respectively, depending on the specific classification criteria used. These suggest that while the present study's test demonstrated specificity

(96%), other diagnostic systems like TI-RADS may offer slightly lower but still substantial specificity and sensitivity values. This highlights the consistency of the present study's findings with the broader literature, even though minor differences exist, possibly due to variations in study populations or diagnostic criteria.

Dy et al,[9] also reported similar trends, finding that nodules with no echogenic foci were predominantly in lower TIRADS categories, particularly TIRADS 1 and 2, where 80% of nodules lacked echogenic foci, closely aligning with the 75% observed in the present study.

CONCLUSION

Thyroid nodule composition revealed that solid nodules were the most frequent (44%), followed by mixed (38%), and cystic (15%) nodules. The distribution of nodule composition was statistically significant ($p < 0.001$). Echogenic foci or calcifications in thyroid nodules were predominantly absent in 75% of cases, with macrocalcifications seen in 9% and punctate calcifications in 6%. The distribution of echogenic foci was statistically significant ($p < 0.001$). The association between BETHESDA categories and malignancy was highly significant ($p < 0.001$). The sensitivity and specificity of the TIRADS system were high, at 92% and 96%, respectively, indicating its effectiveness in diagnosing malignant thyroid nodules.

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