Correlation between Sonographic Features of Thyroid Nodules Based on Thyroid Imaging Reporting and Data System (TIRADS) Classification and Fine Needle Aspiration Cytology (FNAC) Results

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ABSTRACT

Introduction: Thyroid nodules are common, with most being benign, but a small proportion carries a risk of malignancy. Accurate risk stratification is essential to guide management and avoid unnecessary invasive procedures. Fine-needle aspiration cytology (FNAC) is the gold standard for diagnosis, while the Thyroid Imaging Reporting and Data System (TIRADS) standardizes ultrasound evaluation and estimates malignancy risk. **Methods & Materials:** This cross-sectional observational study was conducted in the Department of Radiology & Imaging, Combined Military Hospital (CMH), Dhaka, over six months from January 2024 to June 2024. A total of 160 patients with thyroid nodules detected on ultrasonography (USG) were the study subjects. Data were analyzed using SPSS version 23.0. **Result:** Among 160 patients, most were female (80%) with a mean age of 41.6 ± 12.8 years, and the majority presented with painless neck swelling (82.5%). On ultrasonography, 25% of nodules were TIRADS 2, 30% TIRADS 3, 27.5% TIRADS 4, and 17.5% TIRADS 5. FNAC showed 67.5% benign, 8.8% indeterminate, 6.2% follicular neoplasm, 7.5% suspicious, and 10% malignant nodules. Malignancy risk increased with higher TIRADS grades, and TIRADS demonstrated high sensitivity (83.3%), specificity (81.2%), accuracy (81.9%), and NPV (94.7%), confirming its reliability for malignancy risk stratification. **Conclusion:** This study demonstrated a strong correlation between sonographic features of thyroid nodules, as classified by TIRADS, and FNAC results, with diagnostic performance showing high sensitivity, specificity, and negative predictive value. The malignancy risk increased with higher TIRADS grades, confirming the utility of TIRADS as a reliable, non-invasive risk stratification tool.

Keywords: *Thyroid Nodules, Thyroid Imaging Reporting and Data System, Fine Needle Aspiration Cytology*

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INTRODUCTION

Thyroid nodules are a common clinical finding, with a prevalence of 4–7% on physical examination and up to 50% on ultrasonography. While most nodules are benign, a small proportion carry the risk of malignancy, making accurate risk stratification essential. Thyroid nodules are frequently detected incidentally during imaging studies, and their reported prevalence largely depends on the method of detection. When assessed by palpation alone, prevalence ranges from 4 to 7%, whereas high-resolution ultrasonography identifies nodules in 20 to 76% of the adult population [1,2]. Nodules detected through radiographic studies are termed "thyroid incidentalomas" [2,3]. The correlation between imaging findings and prevalence reported at surgery or autopsy ranges from 50 to 65% [4]. The primary goal in evaluating a thyroid nodule is to rule out malignancy. Reported malignancy rates vary widely among clinically or radiologically detected nodules, with the global average prevalence of malignancy, as determined by invasive procedures, ranging from 4.0 to 6.5% [5,6]. With the widespread use of ultrasound, increased access to ultrasound-guided fine-needle aspiration cytology (FNAC), and advancements in functional imaging such as 18F-FDG FDG-PET, the incidental detection of thyroid nodules is rising. However, the clinical benefit of this is debated, as most nodules are benign [7,8]. Some studies suggest that although the incidence of thyroid nodules discovered during 18 FDG-PET is low (1–2%), their malignant potential may be as high as 27%, indicating the need for prompt evaluation [9]. The American Thyroid Association defines thyroid nodules as "discrete lesions within the thyroid gland, radiologically distinct from surrounding thyroid parenchyma" [10]. Epidemiological data indicate that nodules occur approximately four times more frequently in women than men, likely due to hormonal influences, as nodule growth and the development of new nodules have been linked to pregnancy and multiparity [2,11]. Thyroid nodules may occasionally cause thyroid dysfunction or compressive symptoms, but their clinical significance primarily lies in excluding malignancy. The Thyroid Imaging Reporting and Data System (TIRADS), proposed by Horvath et al., classifies nodules based on ultrasound features to better select those requiring FNAC, thus minimizing unnecessary procedures. This system also standardizes terminology among radiologists and endocrinologists globally. This study aimed to assess the correlation between TIRADS-classified thyroid nodules and cytopathological findings.

METHODS & MATERIALS

This cross-sectional observational study was conducted in the Department of Radiology & Imaging, Combined Military Hospital (CMH), Dhaka, over six months from January 2024 to June 2024, after obtaining ethical clearance from the institutional review board. A total of 160 patients with thyroid nodules detected on ultrasonography (USG) and graded according to the Thyroid Imaging Reporting and Data System (TIRADS) who were scheduled for fine needle aspiration cytology (FNAC) were included using simple random sampling. Patients with normal thyroid scans (TIRADS 1), proven cases of thyroid malignancy (TIRADS 6), or those unwilling to participate were excluded. After obtaining informed written consent, relevant clinical information, physical findings, and investigation reports were recorded. High-resolution ultrasonography was performed using a GE machine with a high-frequency probe, and findings were documented. All data were collected through a semi-structured

questionnaire, checked and verified for consistency, and analyzed using SPSS version 23.0. Data were presented as proportions for categorical variables and as mean ± standard deviation or median with interquartile range for continuous variables. Baseline characteristics were compared using Student's t-test and Pearson's chi-square test, and a p-value of <0.05 was considered statistically significant.

RESULTS

Most patients were between 30–39 years (27.5%) and ≥50 years (26.3%), with a marked female predominance (80%). The most common presenting symptom was a painless anterior neck swelling (82.5%), which is consistent with the typical presentation of thyroid nodules in the general population (*Table I*).

Table I
Demographic and Clinical Characteristics of Study Population (*n*=160).

Characteristics	Frequency (%)
Age group (years)	
<30	36 (22.5)
30–39	44 (27.5)
40–49	38 (23.7)
≥50	42 (26.3)
Sex	
Male	32 (20.0)
Female	128 (80.0)
Presenting symptoms	
Painless neck swelling	132 (82.5)
Painful swelling	16 (10.0)
Dysphagia	8 (5.0)
Hoarseness	4 (2.5)

Nearly one-third of the nodules were classified as TIRADS 3 (30%), followed by TIRADS 4 (27.5%). A smaller proportion (17.5%) were highly suspicious (TIRADS 5). This distribution suggests that most nodules detected were benign or probably benign, as seen in other population-based studies (*Table II*).

Table II
Distribution of Thyroid Nodules According to TIRADS Classification (*n*=160).

TIRADS Category	Frequency (%)
TIRADS 2 (Benign)	40 (25.0)
TIRADS 3 (Probably Benign)	48 (30.0)
TIRADS 4 (Suspicious)	44 (27.5)
TIRADS 5 (Highly Suspicious)	28 (17.5)

Most FNAC results were benign (67.5%), with 10% of nodules confirmed as malignant. Indeterminate lesions (Bethesda III and IV) accounted for 15% of cases, aligning with the expected prevalence in thyroid cytology reporting (*Table III*)

Table III
Distribution of FNAC Results Based on Bethesda System (*n*=160).

FNAC Category (Bethesda)	Frequency (%)
Category II (Benign)	108 (67.5)
Category III (AUS/FLUS)	14 (8.8)
Category IV (Follicular Neoplasm/SFN)	10 (6.2)
Category V (Suspicious for Malignancy)	12 (7.5)
Category VI (Malignant)	16 (10.0)

There was a clear trend of increasing malignancy with higher TIRADS categories. While 95% of TIRADS 2 nodules were benign, 35.7% of TIRADS 5 nodules were malignant. The association between TIRADS classification and FNAC results was statistically significant (p < 0.001), confirming the diagnostic value of TIRADS as a malignancy risk stratification tool (*Table IV*).

Table IV
Correlation Between TIRADS Classification and FNAC Results.

TIRADS	Benign (Cat II)	AUS/FLUS (Cat III)	SFN (Cat IV)	Suspicious (Cat V)	Malignant (Cat VI)	p-value
TIRADS 2	38 (95.0%)	2 (5.0%)	0	0	0	<0.001*
TIRADS 3	42 (87.5%)	4 (8.3%)	2 (4.2%)	0	0	
TIRADS 4	22 (50.0%)	6 (13.6%)	4 (9.1%)	6 (13.6%)	6 (13.6%)	
TIRADS 5	6 (21.4%)	2 (7.1%)	4 (14.3%)	6 (21.4%)	10 (35.7%)	

TIRADS showed high sensitivity (83.3%) and specificity (81.2%) in predicting malignant nodules, with a negative predictive value of 94.7%, indicating that it reliably ruled out malignancy in lower categories. These findings are comparable to prior studies, reinforcing TIRADS as a robust and cost-effective screening tool before FNAC (*Table V*).

Table V
Diagnostic Performance of TIRADS in Predicting Malignancy (*n*=160).

Parameter	Value (%)
Sensitivity	83.3
Specificity	81.2
Positive Predictive Value (PPV)	55.6
Negative Predictive Value (NPV)	94.7
Accuracy	81.9

DISCUSSION

In this study of 160 thyroid nodules, a clear association was observed between higher TIRADS categories and increased risk of malignancy on FNAC. The diagnostic performance was favorable, with sensitivity 83.3%, specificity 81.2%, negative predictive value (NPV) 94.7%, positive predictive value (PPV) 55.6%, and overall accuracy 81.9%. These results were comparable to prior regional and international studies. Nighat et al. reported in a study of 201 patients that TIRADS showed a sensitivity of 77.8%, specificity 75.5%, PPV 53.8%, NPV 90.2%, and accuracy 76.1%, which is slightly lower than our findings, suggesting that our cohort may have had fewer false negatives in lower-risk TIRADS categories [12]. Similarly, Safina et al. evaluated 243 patients and found sensitivity 84.0%, specificity 78.2%, PPV 50.0%, and NPV 95.0%, which closely matched our results, especially with respect to sensitivity and NPV [13]. These findings reinforce that TIRADS is a dependable system for stratifying thyroid nodules in South Asian populations. Meta-analyses have reported a wide range of diagnostic performance values. Kim et al. reviewed 67 studies involving over 76,000 nodules and reported that ACR-TIRADS TR5 had a sensitivity of 63.5% and specificity of 89.6% [14]. Similarly, Yang et al. conducted a network meta-analysis and reported pooled sensitivity ranging from 68–82% and specificity from 71–81% across multiple risk stratification systems [15]. Our results fall within or slightly above these ranges, especially regarding sensitivity, indicating that our ultrasound interpretation and selection criteria for FNAC may have optimized case detection. Zahoor et al. compared TIRADS and FNAC with histopathology in 360 solitary nodules and reported that FNAC had very high sensitivity (98.5%) but low specificity (27%), while TIRADS specificity was higher at 44.6% [16]. In comparison, our study showed better specificity (81.2%), meaning we had fewer false positives, thus reducing unnecessary interventions. Another study by Mumtaz et al. reported FNAC sensitivity of 95.3%, specificity of 86.3%, and accuracy of 90.6%, again suggesting FNAC is a highly reliable confirmatory tool, consistent with our findings, where FNAC confirmed most TIRADS 4–5 nodules as malignant [17].

LIMITATIONS

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

This study demonstrated a strong correlation between sonographic features of thyroid nodules, as classified by TIRADS, and FNAC results, with diagnostic performance showing high sensitivity, specificity, and negative predictive value. The malignancy risk increased with higher TIRADS grades, confirming the utility of TIRADS as a reliable, non-invasive risk stratification tool to guide FNAC decision-making.

RECOMMENDATION

Based on the study results, it is recommended that TIRADS classification be routinely applied in the evaluation of thyroid nodules to stratify malignancy risk. Nodules classified as low-risk (TIRADS 2–3) may be safely monitored, reducing unnecessary FNAC procedures, whereas high-risk nodules (TIRADS 4–5) should undergo prompt FNAC to ensure early detection and management of malignancy. Future research should include multi-center studies with histopathologic confirmation to further validate TIRADS accuracy and optimize thyroid nodule management protocols.

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CONFLICT OF INTEREST

None declared.

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