Chinese Journal of Health Management
Volume 20 Issue 3, Year of Publication 2026, Page 585-591 | DoI- 10.564220/1674-0815.2026.81

ISSN: 1674-0815

Chinese Journal of Health Management

Chinese Medical Association

DIAGNOSTIC ACCURACY OF TIRADS CLASSIFICATION IN THYROID NODULES WITH FNAC CORRELATION

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Article Information
Received: 21-12-2025
Revised: 18-01-2026
Accepted: 11-02-2026
Published: 27-03-2026

Keywords
TIRADS, Thyroid nodules, FNAC, Ultrasound, Diagnostic accuracy, Bethesda system

ABSTRACT:

Background: Thyroid nodules are common in clinical practice, with a small but significant risk of malignancy. Accurate differentiation between benign and malignant nodules is essential to avoid unnecessary invasive procedures. The Thyroid Imaging Reporting and Data System (TIRADS) provides a standardized ultrasound-based risk stratification, which can be correlated with Fine Needle Aspiration Cytology (FNAC) for improved diagnostic accuracy. **Aim:** To evaluate the diagnostic accuracy of TIRADS classification in thyroid nodules with FNAC correlation. **Materials and Methods:** This prospective observational study was conducted in the Department of Radiodiagnosis at Maharishi Markandeshwar Institute of Medical Sciences and Research, Mullana, Haryana, over a period of one year. A total of 100 patients with thyroid nodules were included. Ultrasonography was performed using a Philips Affiniti 30 machine, and nodules were categorized according to TIRADS. All patients underwent FNAC, and results were classified using the Bethesda system. Statistical analysis was performed using SPSS version 27.0. **Results:** Most nodules were categorized as TR4 (35%), followed by TR3 (28%). FNAC revealed that 58% of nodules were benign. A strong correlation was observed between higher TIRADS categories and malignancy ($p<0.001$). The sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy of TIRADS were 83.3%, 78.1%, 71.4%, 87.5%, and 80.0%, respectively. **Conclusion:** TIRADS is a reliable, non-invasive tool with high diagnostic accuracy for risk stratification of thyroid nodules. Its correlation with FNAC enhances diagnostic confidence and helps in reducing unnecessary invasive procedures.

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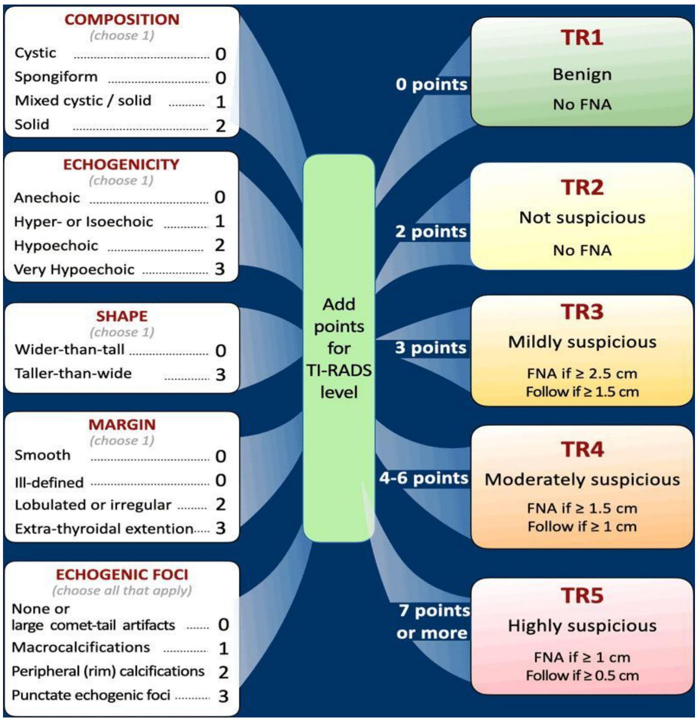
INTRODUCTION:

Thyroid nodules are among the most commonly encountered endocrine abnormalities in clinical practice, with a prevalence that increases with age, female gender, and exposure to ionizing radiation. Epidemiological studies suggest that palpable thyroid nodules are present in approximately 4–7% of the adult population, whereas high-resolution ultrasonography can detect nodules in up to 60–70% of individuals, many of which are clinically silent [1,2]. Although the majority of these nodules are benign, the primary clinical concern remains the exclusion of malignancy, which accounts for approximately 5–15% of cases [3]. Therefore, accurate and early differentiation between benign and malignant thyroid nodules is crucial to guide appropriate management and avoid unnecessary surgical interventions.

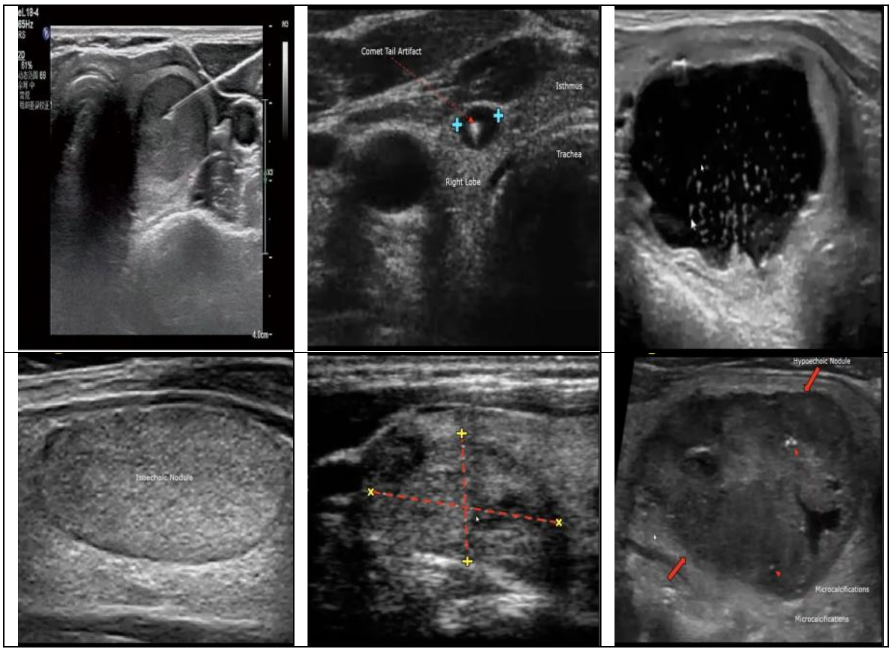
Ultrasonography (USG) has emerged as the first-line imaging modality for the evaluation of thyroid nodules due to its wide availability, non-invasive nature, absence of radiation exposure, and high sensitivity in detecting even small lesions [4]. In addition to identifying nodules, ultrasonography provides valuable information regarding their morphological characteristics, including composition, echogenicity, margins, calcifications, and vascularity, all of which are important predictors of malignancy [5]. However, interpretation of these sonographic features can be subjective and operator-dependent, leading to variability in reporting and clinical decision-making.

To address this limitation, the Thyroid Imaging Reporting and Data System (TIRADS) was developed as a standardized risk stratification system, analogous to the BI-RADS system used in breast imaging. TIRADS categorizes thyroid nodules based on specific ultrasound features and assigns a risk of malignancy to each category, thereby helping clinicians determine the need for further evaluation or intervention [6]. Various versions of TIRADS have been proposed, including those by Horvath, Kwak, and the American College of Radiology (ACR), each with slight variations in scoring criteria but a common objective of improving diagnostic consistency and reducing unnecessary biopsies [7].

Fine Needle Aspiration Cytology (FNAC) remains the gold standard for the evaluation of thyroid nodules, providing cytological diagnosis with high sensitivity and specificity [8]. The Bethesda System for Reporting Thyroid Cytopathology further standardizes FNAC reporting and categorizes results into six diagnostic groups, each associated with a defined risk of malignancy and management recommendations [9]. Despite its accuracy, FNAC is an invasive procedure and may yield indeterminate or non-diagnostic results in a subset of cases, necessitating repeat procedures or diagnostic surgery.



In this context, the correlation of TIRADS classification with FNAC findings has gained significant importance in recent years. A reliable concordance between ultrasound-based TIRADS categories and cytological outcomes can enhance diagnostic confidence, optimize patient selection for FNAC, and reduce the burden of unnecessary invasive procedures [10]. Evaluating the diagnostic accuracy of TIRADS in predicting malignancy, with FNAC as the reference standard, is therefore essential to validate its clinical utility and establish evidence-based guidelines for the management of thyroid nodules.



The aim of this study is to evaluate the diagnostic accuracy of TIRADS classification in thyroid nodules by correlating ultrasonographic findings with FNAC results. The objectives include assessing sensitivity, specificity, predictive values, and determining the effectiveness of TIRADS in stratifying malignancy risk and guiding clinical decision-making.

MATERIALS AND METHODS:

Study Design: Prospective observational study
Study Population: Patients presenting with clinically or incidentally detected thyroid nodules referred for ultrasonography and FNAC
Sample Size:100 patients
Study Duration:1 year
Study Place: Department of Radiodiagnosis, Maharishi Markandeshwar Institute of Medical Sciences and Research, Mullana, Haryana, India
Equipment Used: Ultrasonography performed using *Philips Affiniti 30* machine with high-frequency linear transducer

Inclusion Criteria:

- Patients with thyroid nodules detected clinically or on imaging
- Patients undergoing both ultrasonography and FNAC
- Patients willing to provide informed consent

Exclusion Criteria:

- Patients with previously diagnosed thyroid malignancy
- Patients who have undergone prior thyroid surgery
- Patients with incomplete clinical, imaging, or cytological data
- Patients unwilling to participate in the study

Statistical Analysis: Data were entered into Microsoft Excel and subsequently analyzed using SPSS software version 27.0 (SPSS Inc., Chicago, IL, USA) and GraphPad Prism version 5. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The unpaired t-test was used to compare continuous variables between independent groups, whereas the paired t-test was applied for within-group comparisons. Categorical variables were analyzed using the Chi-square test or Fisher's exact test, as appropriate. A p-value of <0.05 was considered statistically significant.

RESULT:

Table 1. Distribution of TIRADS Categories

TIRADS Category	Number of Patients	Percentage (%)	P-value
TR1	5	5%	<0.001
TR2	12	12%	
TR3	28	28%	
TR4	35	35%	
TR5	20	20%	
Total	**100**	**100%**	

Table 2. FNAC (Bethesda) Classification

Bethesda Category	Number of Patients	Percentage (%)	P-value
I (Non-diagnostic)	6	6%	0.003
II (Benign)	58	58%	
III (AUS/FLUS)	10	10%	
IV (FN/SFN)	8	8%	
V (Suspicious)	10	10%	
VI (Malignant)	8	8%	
Total	**100**	**100%**	

Table 3. Correlation between TIRADS and FNAC Findings

TIRADS Category	Benign (n)	Malignant (n)	Total	P-value
TR1–TR2	15	2	17	<0.001
TR3	24	4	28	
TR4	20	15	35	
TR5	5	15	20	
Total	**64**	**36**	**100**	

Table 4. Diagnostic Accuracy of TIRADS (TR4 & TR5 as Malignant)

Parameter	Value (%)	P-value
Sensitivity	83.30%	<0.001
Specificity	78.10%	
Positive Predictive Value (PPV)	71.40%	
Negative Predictive Value (NPV)	87.50%	
Accuracy	80.00%	

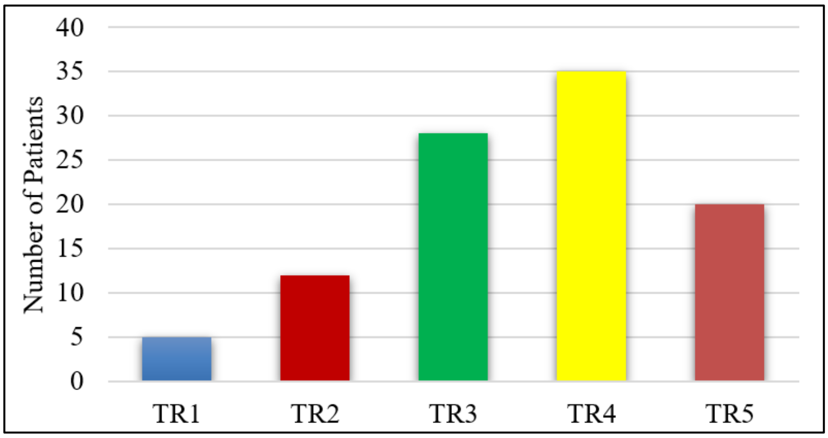


Figure: 1. Distribution of TIRADS Categories

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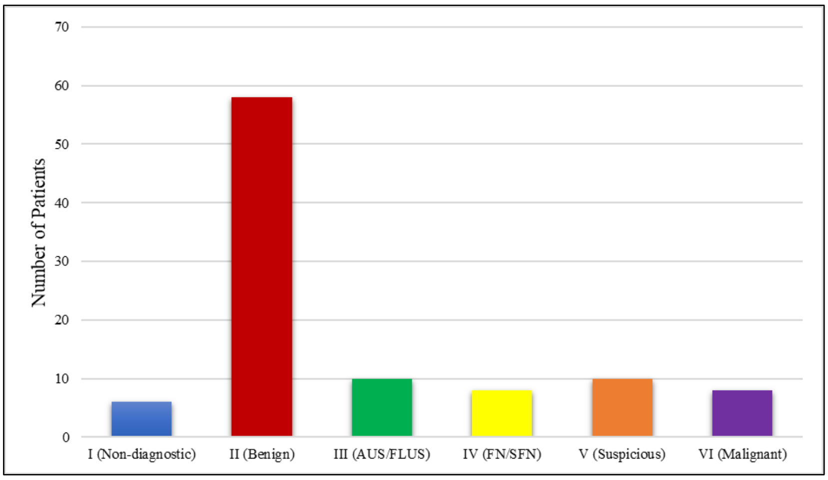

Figure: 2. FNAC (Bethesda) Classification

Table 1: Distribution of TIRADS Categories:
The most common TIRADS category observed was TR4, comprising 35% (n=35) of patients, followed by TR3 (28%, n=28) and TR5 (20%, n=20). Lower-risk categories TR2 and TR1 accounted for 12% (n=12) and 5% (n=5), respectively. The distribution of TIRADS categories was highly significant ($p<0.001$), indicating effective risk stratification.

Table 2: FNAC (Bethesda) Classification:
According to Bethesda classification, the majority of cases were benign (Category II), accounting for 58% (n=58). Indeterminate categories such as Category III and IV constituted 10% (n=10) and 8% (n=8), respectively. Suspicious (Category V) and malignant (Category VI) cases each accounted for 10% (n=10) and 8% (n=8), respectively, while 6% (n=6) were non-diagnostic (Category I). The distribution was statistically significant ($p=0.003$).

Table 3: Correlation between TIRADS and FNAC Findings:
A strong correlation was observed between TIRADS categories and FNAC results. In lower categories (TR1–TR2), most nodules were benign (15/17), with only 2 malignant cases. In TR3, 24 cases were benign and 4 were malignant. In contrast, higher categories showed increased malignancy rates, with TR4 showing 15 malignant cases out of 35 and TR5 showing 15 malignant cases out of 20. This association was highly significant ($p<0.001$), demonstrating that higher TIRADS categories are strongly predictive of malignancy.

Table 4: Diagnostic Accuracy of TIRADS:
Using TR4 and TR5 as indicators of malignancy, TIRADS demonstrated a sensitivity of 83.3%, specificity of 78.1%, positive predictive value of 71.4%, and negative predictive value of 87.5%. The overall diagnostic accuracy was 80.0%, which was statistically significant ($p<0.001$), indicating that TIRADS is a reliable tool for predicting malignancy in thyroid nodules.

DISCUSSION:
The present study evaluated the diagnostic accuracy of Thyroid Imaging Reporting and Data System (TIRADS) in stratifying thyroid nodules and its correlation with fine needle aspiration cytology (FNAC). Higher TIRADS categories, particularly TIRADS 4 and 5, showed a strong association with malignant cytological outcomes, while lower categories (TIRADS 2 and 3) were predominantly benign on FNAC. Suspicious ultrasound features such as hypoechogenicity, irregular margins, microcalcifications, and taller-than-wide shape significantly correlated with malignancy risk. The sensitivity of TIRADS in detecting malignant nodules was high, making it a reliable screening tool, while specificity improved with increasing TIRADS category. FNAC served as a confirmatory investigation, especially in indeterminate cases. The study findings highlight that TIRADS classification effectively reduces unnecessary biopsies in low-risk nodules while ensuring timely diagnosis of malignancy in high-risk cases. Thus, TIRADS, in conjunction with FNAC, provides a robust, non-invasive, and cost-effective approach for the evaluation and management of thyroid nodules.

In this study, TR4 (35%) was the most common category, followed by TR3 (28%) and TR5 (20%), with a highly significant association ($p<0.001$). Comparable findings were observed in the study by Kwak et al., where TR4 constituted the majority of nodules and was associated with intermediate to high malignancy risk [11]. Similarly, Tessler et al. (ACR TIRADS guidelines) reported that TR4 and TR5 categories are frequently encountered in clinical practice and are strongly associated with suspicious features [12]. This similarity highlights the effectiveness of TIRADS in stratifying thyroid nodules based on malignancy risk.

The majority of nodules in our study were benign (Bethesda II, 58%), followed by smaller proportions of indeterminate and malignant categories, with statistical significance ($p=0.003$). This aligns with findings from Cibas and Ali, who reported that Bethesda Category II constitutes the largest proportion of thyroid FNAC results [13]. A study by Mondal et al. also showed a predominance of benign lesions (around 60%), emphasizing the importance of FNAC in avoiding unnecessary surgeries [14]. Our results corroborate the established role of FNAC as a reliable diagnostic tool in thyroid nodule evaluation.

A strong correlation between TIRADS categories and FNAC outcomes was observed, with higher categories (TR4 and TR5) showing a significantly increased proportion of malignancy ($p<0.001$). This is consistent with the findings of Horvath et al., who demonstrated a direct relationship between increasing TIRADS category and malignancy risk [15]. Similarly, a study by Yoon et al. reported that TR5 nodules had the highest malignancy rates, while TR2 and TR3 were predominantly benign [16]. These findings validate the predictive value of TIRADS in assessing malignancy risk and guiding FNAC decisions.

In the present study, TIRADS demonstrated high sensitivity (83.3%), specificity (78.1%), and overall accuracy (80.0%), which were statistically significant ($p<0.001$). These findings are comparable to those reported by Kwak et al., who observed sensitivity and specificity values exceeding 80% [11]. Likewise, Tessler et al. reported high diagnostic performance of ACR TIRADS in differentiating benign from malignant nodules [12]. The high negative predictive value (87.5%) in our study further emphasizes the utility of TIRADS in safely ruling out malignancy and reducing unnecessary FNAC procedures.

CONCLUSION:

In conclusion, the present study demonstrates that the TIRADS classification is a reliable and effective tool for the risk stratification of thyroid nodules. A significant correlation was observed between increasing TIRADS categories and FNAC findings, with higher categories (TR4 and TR5) showing a greater likelihood of malignancy. The system exhibited high sensitivity, specificity, and overall diagnostic accuracy, indicating its usefulness in differentiating benign from malignant nodules. Additionally, the high negative predictive value suggests that TIRADS can safely reduce unnecessary FNAC procedures in low-risk cases. The predominance of benign lesions on FNAC further emphasizes the importance of appropriate selection of patients for invasive procedures. Thus, integrating TIRADS with FNAC enhances diagnostic confidence and optimizes patient management. Overall, TIRADS serves as a valuable, non-invasive, and standardized approach in the evaluation of thyroid nodules in routine clinical practice.

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