ORIGINAL RESEARCH PAPER
Volume - 15 | Issue - 05 | May - 2026 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

CORRELATION OF ULTRASOUND-BASED ACR-TIRADS WITH HISTOPATHOLOGY IN THYROID NODULES: A PROSPECTIVE STUDY

Clinical Radiology

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ABSTRACT

Background: Thyroid nodules are very commonly seen in clinical practice, especially with the increasing use of ultrasound. While most of these nodules are benign, identifying the small proportion that are malignant remains a key challenge. The ACR-TIRADS system was developed to provide a standardized way of assessing thyroid nodules and estimating their risk of malignancy. **Objective:**To evaluate how accurately ACR-TIRADS can predict malignancy in thyroid nodules and to assess its correlation with histopathological findings. **Methods:**This prospective observational study included 120 patients with thyroid nodules who underwent ultrasound evaluation followed by FNAC and/or surgical histopathology. Nodules were classified according to ACR-TIRADS (TR1–TR5). Histopathology was taken as the gold standard. Diagnostic parameters such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated. ROC analysis was also performed. **Results:**The likelihood of malignancy increased steadily with higher TIRADS categories. No malignancy was seen in TR1 nodules, while malignancy rates were 5.5% in TR2, 12.9% in TR3, 41.9% in TR4, and 83.3% in TR5. When TR4 and TR5 were considered suspicious for malignancy, TIRADS showed a sensitivity of 90.3% and specificity of 82.5%. The PPV and NPV were 78.3% and 92.2%, respectively, with an overall diagnostic accuracy of 86.1%. ROC analysis demonstrated excellent performance with an AUC of 0.903. The association between TIRADS category and malignancy was statistically significant ($p < 0.001$). **Conclusion:**ACR-TIRADS is a practical and reliable tool for evaluating thyroid nodules. It correlates well with histopathological findings and helps in identifying high-risk nodules while avoiding unnecessary procedures in low-risk cases. Its routine use can improve clinical decision-making and patient management.

KEYWORDS

TIRADS; thyroid nodule; ultrasound; malignancy; histopathology; FNAC

INTRODUCTION

Endocrine abnormalities seen in clinical practice include thyroid nodules, which appear to be the most widespread. As high-resolution ultrasonography becomes widespread, they have been increasingly detected, with prevalence rates as high as 50%-60% in the general population. But very few of these nodules usually 5-15 percent are malignant, and risk stratification, which is typically an essential part of diagnosis, must be done accurately, to prevent over diagnosis and over treatment (1).

The first imaging modality that can be used to assess thyroid nodules is ultrasonography since it is non-invasive, highly sensitive, and widely available in the assessment of morphological characteristics that are indicative of malignancy. There is a series of ultrasound-based risk stratification systems, which have been suggested over time when aiming to standardize reporting and inform clinical decision-making. Of these, the most widely adopted one is the American College of Radiology Thyroid Imaging Reporting and Data System (ACR-TIRADS) which uses a structured scoring system consisting of points that divide nodules into five risk levels (TR1-TR5) based on certain sonographic parameters including their compositions, echogenicity, margins, shape, and echogenic foci.(2).

The ultimate objective of TIRADS is to lower the rate of unnecessarily fine-needle aspiration cytology (FNAC) in low-risk nodules but not to delay the assessment of suspicious nodules. It has been established that an increase in TIRADS scores correlates with a higher likelihood of malignancy, reinforcing the use of the tool as a risk stratification tool to identify women at increased risk in both high and low-risk populations (3).Nonetheless, differences in reported diagnostic performances across populations indicate that a continuous validation of the method is required, especially in heterogeneous clinical environments.

Histopathological test is the gold standard in the definite diagnosis of thyroid malignancy. Thus, it is essential to correlate the classification of ultrasound-based TIRADS with its outcome in terms of histopathology to evaluate the actual diagnostic accuracy and clinical usefulness of the tool. This correlation can not only increase trust in making decisions based on imaging but also assists in tightening the requirements on FNAC and surgery.

In that regard, the current research was conducted to test the diagnostic effectiveness of ACR-TIRADS in terms of the potential malignancy in the thyroid nodules and to find out how it correlates with the histopathological outcomes of a prospective cohort of individuals.

Aim

To evaluate the diagnostic accuracy of ACR-TIRADS in thyroid nodules and its correlation with histopathology.

Objectives

1.To assess the role of ACR-TIRADS in risk stratification of thyroid nodules.
2.To evaluate its utility in guiding FNAC decisions.
3.To determine its effectiveness in reducing unnecessary invasive procedures.
4.To assess its ability to identify malignant nodules early and aid clinical management.

Materials and Methods

This preliminary observational study was undertaken in the Department of Radiodiagnosis in Baba Kinaram autonomus state medical college, Chandauli, India over a span of 9 months between January 2025 and February 2026 after having received the approval of the Institutional Ethics Committee, and all participants given written informed consent. The study involved 120 patients over the age of 18 years who reported with one or more thyroid nodules, which were

diagnosed either clinically or as incidental findings during an ultrasonography. Only the patients that later had fine-needle aspiration cytology (FNAC) and/or surgical excision with histopathological analysis were included, whereas those that only contained cystic nodules without solid components, patients with a history of previously undergone thyroid surgery or radioiodine treatment, inadequate or non-diagnostic cytology/histopathology, or lost to follow-up were excluded.

High-resolution ultrasonography was performed on all patients with a frequency of 712 MHz and a linear transducer. The composition of each nodule of the thyroid, echogenicity, shape, margins and echogenic foci were also evaluated systematically. On the basis of such sonographic features the nodules were graded and graded on the basis of the American College of Radiology Thyroid Imaging Reporting and Data System (ACR-TIRADS) into TR1 (benign), TR2 (not suspicious), TR3 (mildly suspicious), TR4 (moderately suspicious), and TR5 (highly suspicious). FNAC was done based on the nodule size and nodule-TIRADS recommendations and size criteria and cytological results were reported based on the Bethesda System of Reporting Thyroid Cytopathology (Bethesda categories I- VI). Histopathological investigation of excised material in surgical patients was deemed gold standard and the results were coded as benign or malignant to analyze them.

All the data were also incorporated into Microsoft Excel and analyzed with the Statistical Package of the Social Sciences (SPSS) version 25 (IBM Corp., USA). The categories of TIRADS were all associated with the histopathology, and in terms of diagnostic analysis TrumpTR4 and TR5 were positive signs of malignancy and TrumpTR1, TR2, and TR3 were negative (Choi et al., 2007). The parameters of diagnostic such as sensitivity, specificity, positive predictive value, negative predictive value and general accuracy were computed. The Chi-square test was used to ascertain the relationship between TIRADS categories and malignancy with a p-value of below 0.05 deemed to be significant. The receiver operating characteristic (ROC) curve analysis was done to assess the overall diagnostic performance of TIRADS, and area under the curve (AUC) was computed with 95% confidence intervals.

RESULTS

A total of 120 patients with thyroid nodules were included in the study, of which 82 (68.3%) were benign and 38 (31.7%) were malignant on histopathological examination. The distribution of nodules across different TIRADS categories and their correlation with histopathological findings are summarized in Table 1.

Table 1: Distribution of Nodules and Histopathology Correlation

TIRADS Category	Total Nodules	Benign	Malignant	% Malignant
TR1	10	10	0	0%
TR2	18	17	1	5.5%
TR3	31	27	4	12.9%
TR4	43	25	18	41.9%
TR5	18	3	15	83.3%

A progressive increase in the proportion of malignant nodules was observed with increasing TIRADS category. None of the nodules categorized as TR1 were malignant, while malignancy rates were 5.5% in TR2, 12.9% in TR3, 41.9% in TR4, and 83.3% in TR5.

For diagnostic evaluation, TR4 and TR5 categories were considered indicative of malignancy. The diagnostic performance of TIRADS is presented in Table 2, which shows a sensitivity of 90.3%, specificity of 82.5%, positive predictive value (PPV) of 78.3%, negative predictive value (NPV) of 92.2%, and an overall accuracy of 86.1%. A statistically significant association was found between TIRADS categories and histopathological outcomes ($p < 0.001$).

Table 2: Diagnostic Performance of TIRADS

Parameter	Value
Sensitivity	90.3%
Specificity	82.5%
PPV	78.3%
NPV	92.2%
Accuracy	86.1%
p-value	<0.001

Receiver operating characteristic (ROC) analysis demonstrated excellent diagnostic performance, with an area under the curve (AUC) of 0.903 (95% CI: 0.842–0.965), as shown in Table 3.

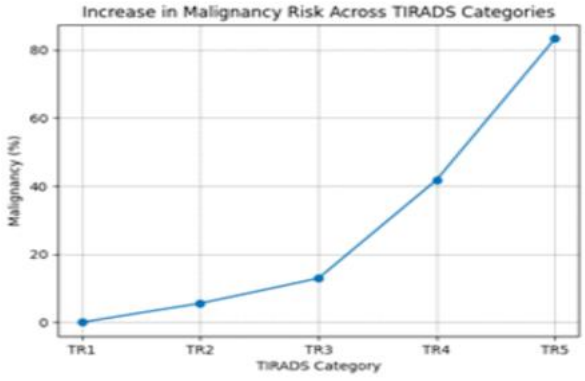
Table 3: ROC Analysis

Parameter	Value
AUC	0.903
95% CI	0.842 – 0.965
Interpretation	Excellent

Furthermore, a clear upward trend in malignancy risk across TIRADS categories is illustrated in Figure 1, reinforcing the effectiveness of TIRADS as a reliable risk stratification tool.

Figure 1: Malignancy Risk Across TIRADS Categories

The graph shows a progressive increase in malignancy risk from TR1 to Tr5.



DISCUSSION

The current research assessed the diagnostic accuracy of ultrasound based ACR-TIRADS to identify thyroid malignancy and proved that such method has a strong correlation to histopathology. There was also a definite and gradual rise in the risk of malignancy as the TIRADS categories were raised, with a strong emphasis on the validity of the structured reporting system in the everyday clinical practice.

The prevalence of malignancy in our study was generally 31.7, as compared to the prevalence of 5-15% usually reported in thyroid nodules. The reason behind such a difference can be linked to the selective attraction of the patients who have either received FNAC and/or surgery, which enhance the percentage of clinically suspicious nodules. This has been observed in other past studies in which there is a tendency of higher malignancy rate in hospital-based cohorts than community-based populations do (1).

One of the main conclusions of our paper was the fact that malignancy rates gradually rising with an increase in TR1 (0%), TR3 (29.6%), TR5 (83.3%), and so on, as in Table 1 and Figure 1. This pattern is also highly consistent with the initial risk stratification across the ACR TIRADS which features increased risk of malignancy with increasing categories. It was also found that a similar progressive increase in the risk of malignancy occurred with the increasing levels of TIRADS with scoring systems based on ultrasound, which supported the validity of the scoring systems based on ultrasound to predict thyroid cancer (3).

TIRADS was found to have high sensitivity (90.3) and specificity (82.5) in our study when TIRADS categories were investigated as being indicative of the presence of malignancy (Table 2). The sensitivity is also great, which implies that TIRADS is effective in detecting malignant nodules and thus a good screening method. Moreover, high negative predictive value (92.2) implies that nodules that present with low risk (TR1 = TR3) can be safely followed without reinventive procedures. These results are in agreement with those by Yoon et al. who concluded that TIRADS has pooled sensitivity and specificity with differentiation of benign and malignant nodules, and that TIRADS is a reliable risk stratification model (4) and a meta-analysis by Zhao et al. also found similar results (5).

Our study of the ROC revealed that the area under the curve (AUC) was 0.903 (Table 3), which is very good diagnostics. This can be compared to the reported literature AUC values, which once again can confirm the strength of TIRADS in a variety of clinical scenarios(3,5). Clinically, the application of TIRADS can decrease the amount of unwarranted FNAC procedures performed on low-risk nodules, and provide prompt intervention in high-risk cases. This is especially crucial in resource-constrained environments, in which the reduction

of an unwarranted set of investigations can help cut down the levels of patient anxiety and of healthcare expenditure. Moreover, the standardized scoring system enhances the inter-observer consistency and better communication between radiologists and clinicians(2).

Limitations

Although it has its strengths, this research has limitations. It was carried out in one center that had a rather small sample size, which could constrain the ability to generalize the results. TIRADS could also be subject to variability in that ultrasound assessment is also operator-dependent. Moreover, we cannot rule out selection bias because patients receiving FNAC or surgery were only chosen to participate in the research.

CONCLUSION

Although it has its strengths, this research has limitations. It was carried out in one center that had a rather small sample size, which could constrain the ability to generalize the results. TIRADS could also be subject to variability in that ultrasound assessment is also operator-dependent. Moreover, we cannot rule out selection bias because patients receiving FNAC or surgery were only chosen to participate in the research.

Acknowledgment

The authors sincerely thank all patients for their participation in this study.

We are grateful to the Departments of Radiodiagnosis and Pathology for their support and collaboration.

We also acknowledge the contributions of all colleagues who assisted in this work.

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