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Ultrasound Evaluation of Thyroid Nodules Using ACR TI-RADS and Its Correlation with Cytopathology

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Abstract: ***Thyroid nodules are commonly detected in clinical practice, yet only a small proportion are malignant, making accurate risk assessment essential for appropriate management. High-resolution ultrasound serves as the primary diagnostic tool, offering detailed evaluation of nodule characteristics. The ACR Thyroid Imaging Reporting and Data System provides a structured approach to classify nodules based on sonographic features and guide the need for fine needle aspiration cytology. A prospective observational study was conducted on fifty patients presenting with thyroid swelling, where ultrasound findings were categorized using ACR TI-RADS and correlated with cytological and histopathological results. The analysis showed a clear increase in malignancy risk with higher TI-RADS categories, while lower categories were largely associated with benign outcomes. Most suspicious ultrasound features demonstrated a meaningful association with malignancy, although certain mixed characteristics showed limited correlation. The findings support the clinical value of ACR TI-RADS as a consistent and practical method for risk stratification, helping reduce unnecessary invasive procedures and improving decision-making, especially in settings with limited resources.***

Keywords: thyroid nodules, ultrasound evaluation, TI-RADS classification, fine needle aspiration, malignancy risk

1. Introduction

Thyroid nodules are frequently encountered in clinical practice, with increasing detection rates due to the widespread use of high-resolution ultrasound. The prevalence is higher in elderly individuals and in regions with iodine imbalance. Despite their high prevalence, only a small percentage of thyroid nodules are malignant, making differentiation between benign and malignant lesions crucial for appropriate management.

High-resolution ultrasound is the first-line imaging modality for thyroid evaluation owing to its availability, cost-effectiveness, and ability to characterize nodules in detail. Sonographic features such as echogenicity, margins, calcifications, shape, and internal composition play a key role in predicting malignancy.

To standardize reporting and minimize unnecessary invasive procedures, the American College of Radiology introduced the Thyroid Imaging Reporting and Data System (ACR TI-RADS). This classification system assigns scores based on ultrasound features and categorizes nodules according to malignancy risk, thereby guiding the need for FNAC.

The present study evaluates thyroid nodules using ACR TI-RADS and correlates sonographic findings with FNAC and/or histopathology to assess its diagnostic utility.

2. Need for the Study

Thyroid nodules are common in the general population; however, the incidence of malignancy remains relatively low. In routine practice, a significant number of benign nodules undergo FNAC, resulting in unnecessary invasive procedures and increased patient anxiety.

Clinical examination and conventional ultrasound alone are often insufficient for reliable malignancy prediction. A structured system such as ACR TI-RADS provides consistency in reporting and decision-making.

Correlation of TI-RADS categories with cytopathological and histopathological findings is essential to validate its effectiveness and to optimize patient management, particularly in resource-limited settings.

3. Review of Literature

Ultrasound has become the primary imaging modality for thyroid nodule evaluation due to its high sensitivity and ability to detect even non-palpable nodules. It allows detailed assessment of nodule morphology, which is essential for malignancy risk prediction.

The TI-RADS classification was initially proposed by Horvath et al. and subsequently refined and standardized by the American College of Radiology. The ACR TI-RADS system aims to reduce unnecessary FNAC while maintaining high diagnostic accuracy.

FNAC remains the gold standard for the diagnosis of thyroid nodules. When combined with ultrasound-based risk stratification systems such as TI-RADS, diagnostic accuracy improves significantly.

4. Materials and Methods

Study Design
Prospective observational study.

Study Population
Fifty patients referred for ultrasound evaluation of thyroid swelling were included in the study.

Inclusion Criteria
- Patients with thyroid mass lesions
- Patients who provided informed consent for ultrasound and FNAC

Exclusion Criteria
- Diffuse thyroid disease without nodules
- Patients unwilling to undergo FNAC

Ultrasound Examination
High-resolution B-mode ultrasound was performed using GE LOGIQ F6 machine with a 5–14 MHz linear transducer. Each thyroid nodule was evaluated for composition, echogenicity, shape, margins, and echogenic foci. Nodules were classified according to ACR TI-RADS.

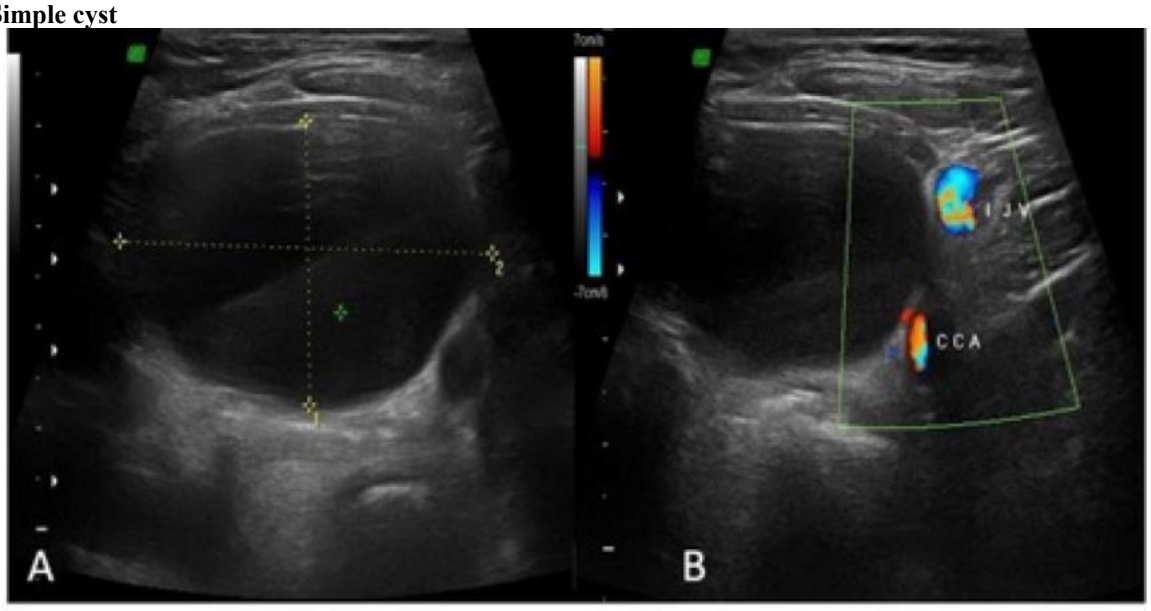
Cytopathological and Histopathological Correlation
Ultrasound findings were correlated with FNAC and/or histopathological results wherever available.

5. Findings and Procedure Details

Analysis of the TI-RADS categories demonstrated that all TI-RADS 2 nodules were benign. The majority of TI-RADS 3 nodules were benign. Most TI-RADS 4 nodules were malignant, and all TI-RADS 5 nodules were malignant.

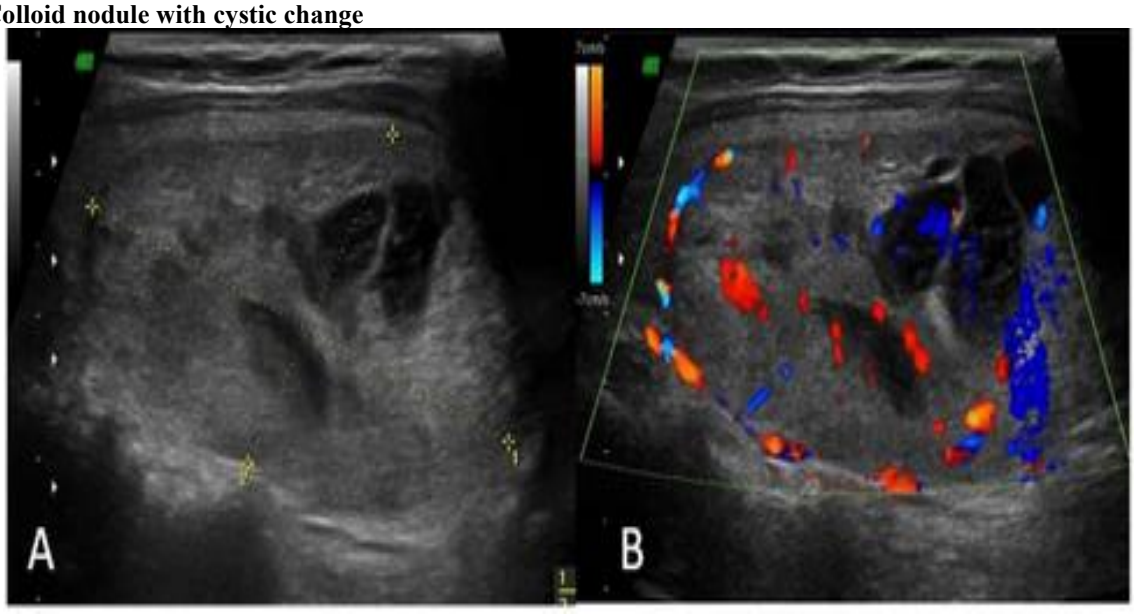
Among the ultrasound features assessed, most suspicious features showed a statistically significant association with malignancy. However, partially cystic nodules with eccentric fluid and lobulation of the solid component did not demonstrate statistically significant correlation.

Case 1: Simple cyst



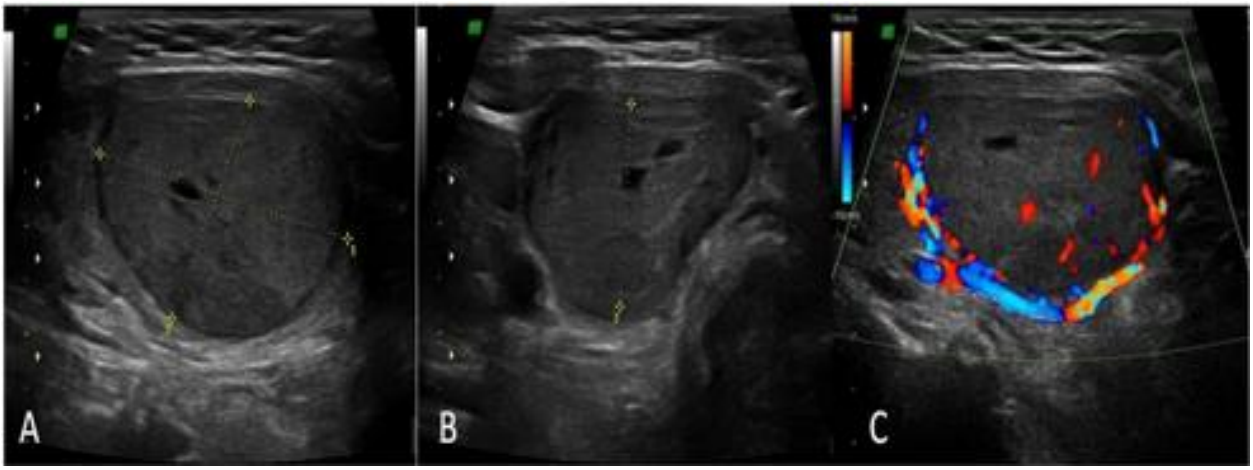
Ultrasound images (A) and (B) show a well-defined cystic lesion in the left lobe of the thyroid gland. (TIRADS 2)

Case 2: Colloid nodule with cystic change



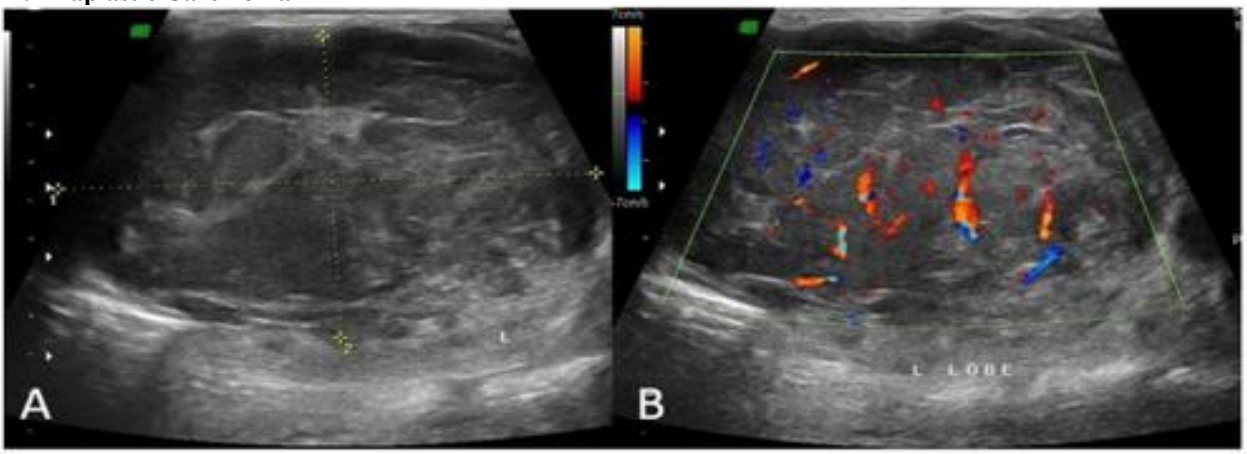
Ultrasound image (A) shows a well-defined wider than tall heterogeneous nodule in the right lobe of the thyroid gland with cystic spaces within. On colour Doppler image (B), the nodule shows predominant peripheral vascularity. (TIRADS 3)

Case 3: Follicular Adenoma



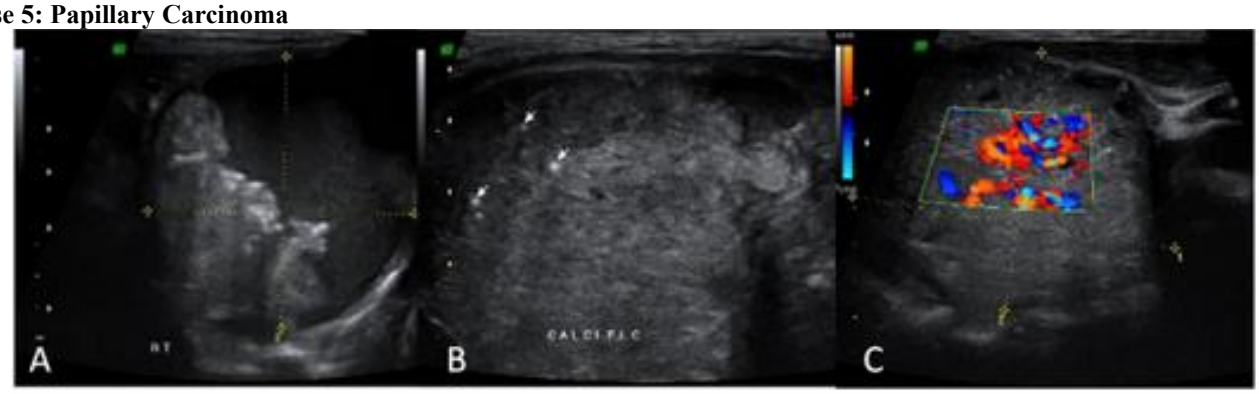
Ultrasound image (A) and (B) shows a well-defined mildly hypoechoic nodule with few cystic areas in the right lobe of the thyroid. On colour Doppler image (C), the nodule shows predominant peripheral vascularity. (TIRADS4A).

Case 4: Anaplastic Carcinoma

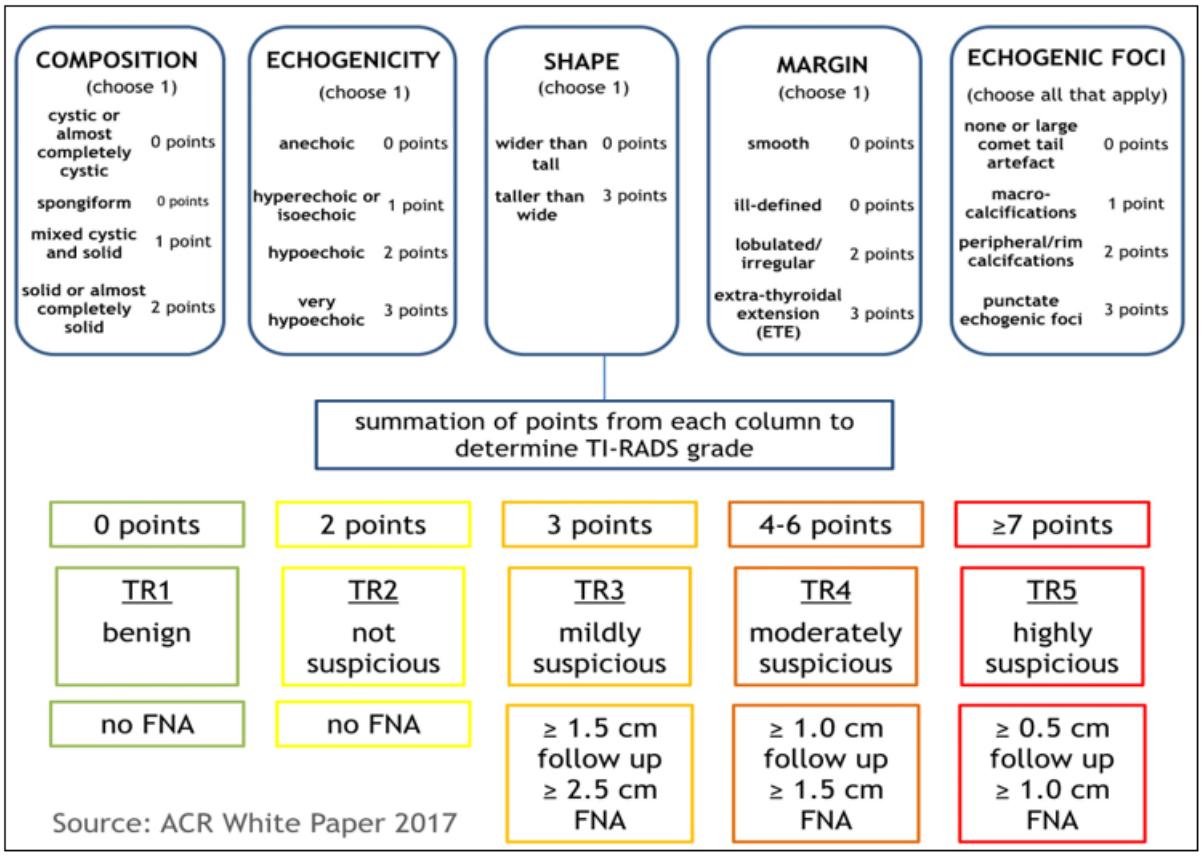


Ultrasound image (A) shows a large well-defined, hypoechoic nodule in the left lobe of the thyroid. On colour Doppler image (B), the nodule shows predominant central vascularity. (TIRADS 4B)

Case 5: Papillary Carcinoma



Ultrasound images (A) and (B) show a large well-defined taller than wide solid cystic nodule in the right lobe of the thyroid with lobulated contour of the solid component. (C) The solid component of the nodule shows heterogeneous echotexture and microcalcifications within. On colour Doppler image (D), the nodule shows extensive internal vascularity. (TIRADS 4C)



Outcome

In the present study, the risk of malignancy associated with TI-RADS categories was as follows:

- TI-RADS 2: 0%
- TI-RADS 3: 1.5%
- TI-RADS 4: 4.8%
- TI-RADS 5: 63% and 100%

These findings indicate a progressive increase in malignancy risk with increasing TI-RADS category

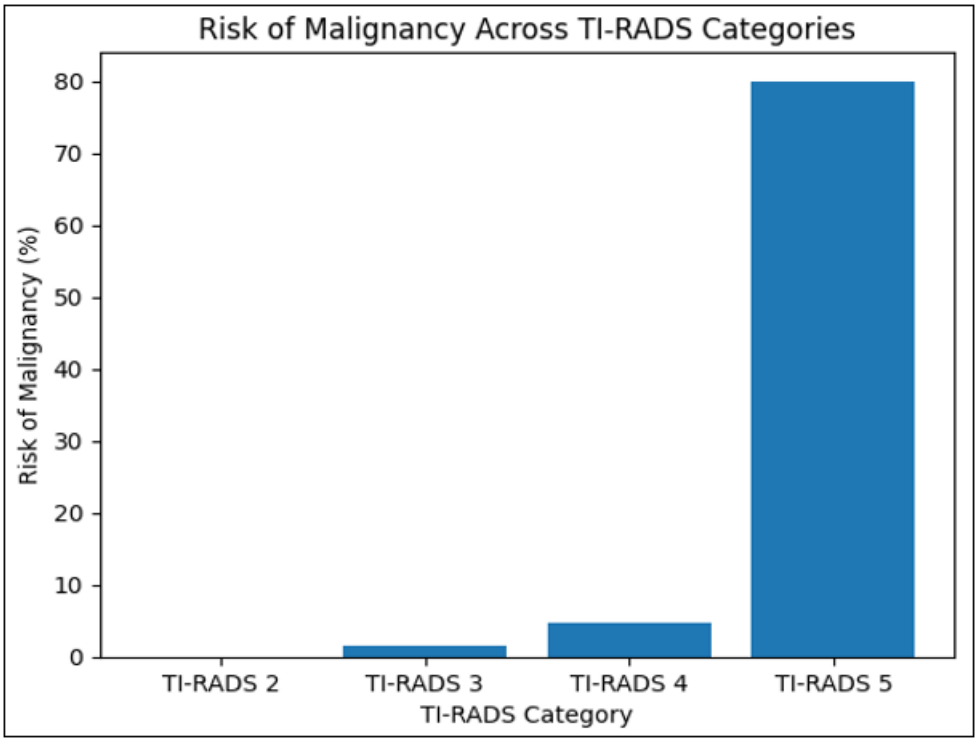


Figure 1: Bar diagram showing the progressive increase in risk of malignancy with increasing ACR TI-RADS category. The risk of malignancy was 0% for TI-RADS 2, 1.5% for TI-RADS 3, 4.8% for TI-RADS 4, and highest for TI-RADS 5 nodules.

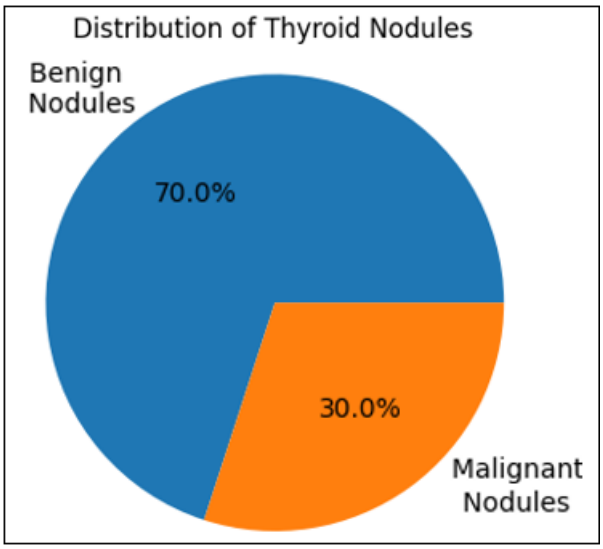


Figure 2: Pie chart illustrating the distribution of benign and malignant thyroid nodules based on FNAC and /or histopathological correlation, showing predominance of benign lesions.

6. Limitations

This study was conducted at a single center, which may limit the generalizability of the results. Ultrasound assessment and TI-RADS categorization are operator-dependent and may vary with the experience of the radiologist. Histopathological confirmation was not available for all cases, as some were correlated only with FNAC. Patients with diffuse thyroid disease without nodules were excluded, limiting the scope to nodular thyroid disease.

7. Conclusion

ACR TI-RADS is a practical, reliable, and non-invasive method for evaluating thyroid nodules in routine clinical practice. It effectively stratifies malignancy risk and reduces unnecessary FNAC in a significant proportion of benign thyroid lesions. The likelihood of malignancy increases with higher TI-RADS categories. Thyroid nodules classified as TI-RADS 3 can be safely followed up, while higher-grade nodules require cytological evaluation. ACR TI-RADS should be adopted as a standardized screening and reporting tool, particularly in resource-constrained settings.

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