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Original Article

Evaluation of Thyroid Nodules on High Resolution Ultrasonography Using Thyroid Imaging Reporting and Data System: Tirads Classification and Histo-Pathological Correlation

Kanti Lal Garasiya[1], Mayank Choudhary[2], Sandeep Kumar Ola[2], Narendra K Kardam[3], Kushal Gehlot[4], Amit Jain[5], Kunal Gehlot[6], Malvika Gehani[7]

[1] Senior Resident, Department of Radiodiagnosis, R.N.T. Medical College, Udaipur
[2]Assistant Professor, Department of Radiodiagnosis, R.N.T. Medical College, Udaipur
[3]Senior Professor and Head, Department of Radiodiagnosis, R.N.T. Medical College, Udaipur
[4]Professor, Department of Radiodiagnosis, R.N.T. Medical College, Udaipur
[5]Senior Resident, Department of Radiodiagnosis, G.M.C., Chittorgarh
[6]Senior Resident, Department of Endovascular & Interventional Radiology, Sir Gangaram Hospital, New Delhi
[7]Senior Resident, Department of Radiodiagnosis, RUHS Medical College, Jaipur

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Corresponding Author:

Kanti Lal Garasiya
Senior Resident, Department of Radiodiagnosis, R.N.T. Medical College, Udaipur
Email: kantigarasiya@gmail.com

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ABSTRACT

Thyroid nodules are relatively common, particularly in hilly regions such as Southern Rajasthan. They are detected in approximately 4–8% of the general population on clinical examination, 20–76% on high-resolution ultrasonography, and in more than 50% of cases at autopsy. The key clinical challenge in evaluating thyroid nodules lies in distinguishing benign from malignant lesions. High-resolution ultrasonography is the preferred initial imaging modality due to its accessibility, sensitivity, and ability to characterize nodular features. The absence of a standardized reporting system historically limited diagnostic consistency. To address this issue, Horvath et al. introduced the Thyroid Imaging Reporting and Data System (TIRADS), which provides a structured framework for risk stratification based on ultrasound features. Despite advances in imaging, fine needle aspiration cytology (FNAC) remains the gold standard for definitive diagnosis, offering high accuracy in differentiating benign from malignant nodules. A combined approach using ultrasonography, TIRADS classification, and FNAC significantly enhances diagnostic confidence and guides appropriate clinical management of thyroid nodules.

Keywords: Thyroid nodules, FNAC, High-resolution ultrasonography, TIRADS.

INTRODUCTION

Thyroid nodules have been defined by the American Thyroid Association (ATA) as “discrete lesions within the thyroid gland, radiologically distinct from surrounding thyroid parenchyma. Thyroid nodules are 16 times more common in females due to the high prevalence of endocrine disorders.(1) High resolution ultrasound is the widely accepted imaging modality use for the initial assessment of thyroid nodules and it helps in differentiating benign from malignant nodules. Over the past decade, with the recent advances in ultrasound (USG) technology with its easy accessibility and availability, there has been increase in detection of thyroid nodules as small as 2 to3 mm, that help in which thyroid nodules are clinically relevant for further evaluation.(1,2) This is in parallel to increased incidence of thyroid cancer worldwide since malignancy comprises approximately 5% of all Thyroid nodules irrespective of size

Thyroid nodules appear highly diverse patterns on high resolution ultrasonography and difficult to accurately classify them into benign and malignant categories. For this Horvath et al in 2009 proposed an evaluation system for thyroid nodules called TIRADS (Thyroid Imaging Reporting and Data System), similar to the BIRADS (Breast Imaging Reporting and

Data System).Thereafter, multiple versions of TIRADS have been proposed using various criteria. The American College of Radiology (ACR) proposed the TIRADS classification in 2015[2] which was further modified in 2017[2] called ACR-TIRADS which is widely used since its introduction in 2017.Based on allocating points for different sonographic features of nodules in five morphologic categories as composition, echogenicity, shape, and margin and echogenic foci.

Fine needle aspiration cytology and biopsy of the thyroid gland help in the management of patients with thyroid lesions. Fine needle aspiration cytology is the best triage for preoperative evaluation and widely accepted as the most accurate, sensitive, specific, and cost-effective diagnostic procedure and considered as reliable, safe and effective method for differentiating between benign and malignant nodules, with a sensitivity of FNAC over 90% and specificity of 75%.[3,5,6] Owing to high occurrence of benign thyroid nodules, the invasive procedure may be precluded. Hence, high resolution ultrasound plays an important pivotal role in characterizing benign and malignant thyroid nodules and avoids unnecessary invasive procedures.

This study aims to analyse and correlate the ubiquity of thyroid nodules such as echogenicity, internal composition, margins, internal calcifications, shape, size, vascularity and involvement of neck nodes and group them into different categories based on TIRADS score. The TIRADS category correlated with the pathological findings, thereby assessing the validity of TIRADS in classifying these thyroid nodules.

MATERIAL AND METHODS

All patients who were presented with thyroid swelling at endocrine, medicine and surgical OPD and IPD department of MBGH Udaipur and associate hospitals of R.N.T. Medical College, Udaipur were included **b**etween June 2023 to July 2024.

Study design: The present study was of observational prospective study.

Sample size: In our study the sample size was calculated by using the formula [$n=(z)^2p(100-p)/d^2$], with expected prevalence of thyroid nodules of 8% and with absolute error 5%. Sample size was of 115. However, a total number of patients was of 135 in our study was examined and included in study.

Inclusion criteria: All patients presenting neck swelling irrespective of sex and age with complain of thyroid disease having swelling or lump in neck with or without neck pain.

Exclusion criteria: Non-thyroidal neck masses; Extreme age of patient; and Diagnosed cases of carcinoma thyroid on follow up for residual disease or recurrence.

Methodology: All patients underwent high-resolution ultrasonography (USG) of the thyroid using linear transducers (5–18 MHz). Scans were performed in the supine position with neck extension, and both transverse and longitudinal images were obtained. Thyroid nodules were evaluated for features such as size, shape, composition, echogenicity, margins, and echogenic foci.

Each nodule was scored and classified according to the ACR-TIRADS system (TR1–TR5). Colour Doppler was used to assess vascularity patterns (absent, peripheral, intra nodular or mixed). Ultrasound-guided FNAC was performed in indicated cases under aseptic precautions. Samples were prepared, stained, and sent for cytological/histopathological analysis. Ultrasound findings were then correlated with FNAC/HPE results. Statistical analysis was performed using SPSS version 22. Diagnostic parameters such as sensitivity, specificity, PPV, NPV, accuracy, and malignancy rate were calculated. Chi-square/Fisher's exact test was used to assess statistical significance.

RESULTS

Out of 135 patients, 24 nodules were malignant, and 111 were benign. Ultrasound features such as hypo echogenicity, micro calcifications, a taller-than-wide shape, lobulated or poorly defined margins, a central or predominantly central pattern of vascularity, and solid composition showed a statistically significant association with malignancy ($p<0.05$). The TIRADS classification demonstrated high sensitivity, specificity, and diagnostic accuracy in differentiating benign from malignant thyroid nodules.

In our study, the prevalence of malignancy was 0% for TR1 and TR2 nodules, 4.25% for TR3 nodules, 16% for TR4 nodules, and 75% for TR5 nodules. In our study, over all prevalence of malignancy was 9.09% for TR3 nodules, 36% for TR4 nodules, and 91.66% for TR5 nodules with histopathological correlation after including the indeterminate and malignant nodule found in cytopathological study.

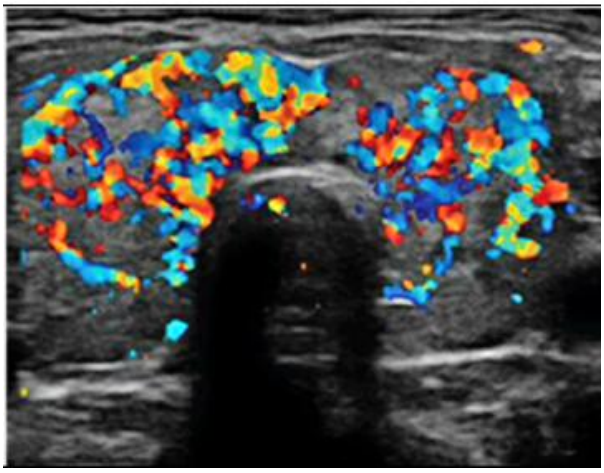
Table 1: Comparison of ACR-TIRADS with the cyto-pathological diagnosis.

ACR-TIRADS score	Benign	Indeterminate	Malignant	Total Number	%

TR1	20(100%)	-	-	20	14.81
TR2	34(100%)	-	-	34	25.18
TR3	37(84.09%)	5(10.9%)	2(4.25%)	44	32.59
TR4	14(56%)	7(28%)	4(16%)	25	18.51
TR5	-	3(25%)	9(75%)	12	8.88
TOTAL	105(77.77%)	15(11.11%)	15 (11.11%)	135	100%

Table 2: Comparison of ACR-TIRADS with the histopathological diagnosis.

ACR-TIRADS	Cytopathological diagnosis (FNAC)			Number of an indeterminate case	Histopathological diagnosis of indeterminate cases (Biopsy)		Total Number	
	Benign	Indeterminate	Malignant		Benign	Malignant	Benign	Malignant
TR1 n=20	20	-	-	-	-	-	20	-
TR2 n=34	34	-	-	-	-	-	34	-
TR3 n=44	37	5	2	5	3	2	40 90.9%	4 9.09%
TR4 n=25	14	7	4	7	2	5	16 64%	9 36%
TR5 n=12	-	3	9	3	1	2	1 8.5%	11 91.66%
Total n=135	105	15	15	15	6	9	111	24



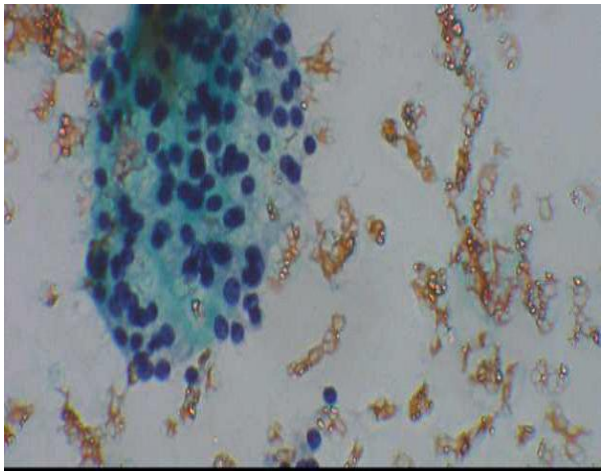
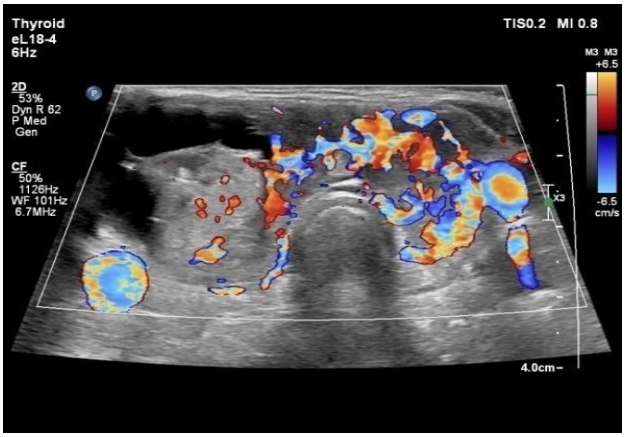


Image 1A (left) *showing High resolution Ultrasound image shows a diffusely enlarged thyroid gland with multiple small, discrete hypoechoic nodules involving both lobes and the isthmus. Colour Doppler demonstrates diffusely increased parenchymal vascularity. These findings suggest a benign diffuse thyroid disease pattern and are categorized as TI-RADS 1.*

Image 1B (right) *showing On FNAC–histopathological correlation, the diagnosis is consistent with Hashimoto's thyroiditis.*



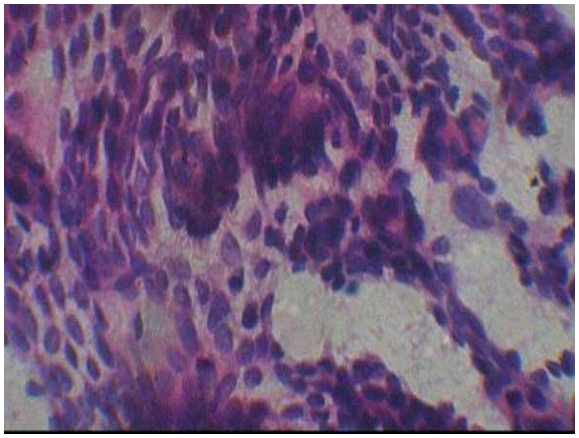


Image 2A (left) *showing Papillary Carcinoma High resolution Ultrasound image shows an ill-defined iso to hyperechoic solid-cystic nodule in the right lobe of the thyroid with both micro and macro calcifications within. On color Doppler image the solid part of nodule shows predominant peripheral vascularity. (TIRADS 5).*
Image 2B (right) *showing on FNAC–histopathological correlation, the diagnosis is consistent with Papillary CA Thyroid*

DISCUSSION

In our study, the age range of patients was 10 to 80 years and the mean age of presentation was 42.16 years, at 95% confidence level. In a study done by Regmi *et al*, the mean age presenting with a thyroid nodule is close to the study findings.[3] In a study done by Devkota *et al*, the mean age of presentation was 41.42 years which was slightly lower than this study.[4]

In our study, the most common age group presenting with thyroid nodules was 31 to 40 years (20.74%), followed by 41 to 50 years (17.77%). A study conducted by Devkota et al. showed the most common age group as 31 to 40 years, which aligns with our findings. Similarly, studies conducted by Bhuyar et al., Abdelkader et al., and Kirdak et al. also reported the highest incidence of thyroid nodules in this younger age group. [4,5]

In our study, there were a higher proportion of females, with a female-to-male ratio of 3.35:1. Similarly, a study by Regmi et al. found that out of 54 cases, 50 (92.6%) were female and 4 (7.4%) were male, resulting in a male-to-female ratio of 1:12.5.[3] Chaudhary et al. also observed a predominance of females, with a male-to-female ratio of 1:19.3.[7] In a study by Bhatta et al. involving 90 patients with thyroid nodules, 72 (80%) were female and 18 (20%) were male, yielding a male-to-female ratio of 1:4. Devkota et al. reported similar findings in their study. [4] Overall, the results of our study suggest that nearly two-thirds of the cases were women, likely due to the significantly higher prevalence of autoimmune thyroid disease in females compared to males.

In our study, the most common site for thyroid nodules was the bilateral involvement (54.81%), followed by the right side (24.44%) then left side (16.24%) and the isthmus (1.48%). Similarly, a study by Regmi et al[3] found that thyroid nodules most commonly presented on the right side (40.7%), followed by bilateral involvement (31.5%). A study by Abdelkader et al[6] reported comparable findings, with 40% of cases involving the right side and 32% involving the left side.

The most common finding in fine-needle aspiration cytology (FNAC) in our study was colloid goitre with or without cystic changes (45.2%), followed by thyroiditis (12.6%) in which out of 17 cases there were 9 cases of lymphocytic thyroiditis. These findings are near similar to those of Chaudhary et al [7], who reported colloid goitre (59.4%) as the most frequent nodule undergoing FNAC, followed by lymphocytic thyroiditis (12%). Similar results were observed by Karki et alstudy. In our study, the prevalence of malignancy was 0% for TR1 and TR2 nodules, 4.25% for TR3 nodules, 16% for TR4 nodules, and 75% for TR5 nodules, consistent with findings from similar studies [3,4,5,6,7]. Our study evaluated the concordance between TIRADS and cytopathological findings of thyroid nodules, showing agreement on benign conditions, particularly in TR1 and TR2 categories. Hernando et al reported similar findings, with high concordance between benign USG findings and Bethesda-II/TIRADS 2 categories. TR5 nodules also correlated well with cytopathological findings, while many TR3 and TR4 nodules were found to be benign, possibly due to the overlap of USG characteristics between benign and malignant nodules and the indeterminate finding in cytopathological findings (12.2% of cases).in this study similar findings were found there were (11.11 % of cases) detected as indeterminate in cytopathological study, which were further undergo for biopsy study.

CONCLUSION

ACR-TIRADS, which is based on the high resolution sonographic morphological characteristics of thyroid nodules, can be used as a screening tool to differentiate between benign and malignant thyroid nodules. However, FNAC or biopsy is recommended for final diagnosis in nodules with TR3 and above, as the risk of malignancy increases with higher TIRADS

grades. Smaller malignant lesions can be mistaken as benign lesion on ultrasound (e.g., Small papillary carcinoma can be mistaken as colloid goitre). There can be inter observer variation on ultrasound evaluation

Distinguishing between follicular neoplasm and follicular adenoma is challenging with both ultrasound and FNAC. Therefore, in high resolution ultrasound examinations, these follicular lesions are classified as adenomatous nodules, while FNAC categorizes them as follicular neoplasm which were further undergoes for biopsy. Even though there are specific characters of benign and malignancy on ultrasound, it may overlap in some cases. So, USG guided FNAC should be done for an accurate diagnosis.

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