



# ORIGINAL RESEARCH PAPER

## CORRELATION BETWEEN ULTRASOUND-BASED ACR TI-RADS AND BETHESDA SYSTEM FOR REPORTING THYROID-CYTOPATHOLOGY: A PROSPECTIVE STUDY AT TERTIARY CARE CENTER IN EASTERN INDIA

### Radiodiagnosis

**KEY WORDS:** Acr Ti-rads; Bethesda; Indian Population; Fnac; Nodules; Thyroid.

**Dr. Kapse Pratik Siddheshwar**

Resident, Department Of Radiodiagnosis, IMS & SUM Hospital, Bhubaneswar, Odisha

**Dr. Beena Devi Agarwal\***

Assistant Professor, Department Of Radiodiagnosis, IMS & SUM Hospital, Bhubaneswar, Odisha \*Corresponding Author

**Dr. S. S. G. Mohapatra**

Head of Department, Department Of Radiodiagnosis, IMS & SUM Hospital, Bhubaneswar, Odisha

**Dr. Niranjana Sahu**

Professor, Department Of Radiodiagnosis, IMS & SUM Hospital, Bhubaneswar, Odisha

**Dr. Apoorva Dixit**

Resident, Department Of Radiodiagnosis, IMS & SUM Hospital, Bhubaneswar, Odisha

### ABSTRACT

**BACKGROUND:** Ultrasound(USG) is the initial imaging tool for the assessment of thyroid lesions, due to its easy availability and no radiation risk. USG based TIRADS uses particular lexicons for reporting a focal thyroid nodule, based on which risk of malignancy is calculated and finally a TIRADS category is assigned. The lexicons used are helpful for effective communication between the practitioners.

**OBJECTIVE:** To determine the efficacy of ACR based TIRADS in predicting suspicious thyroid nodules and categorizing the patients in need of further evaluation with FNAC or follow up.

**MATERIALS AND METHODS:** This prospective study was done over a period of 1 year (January 2019-January 2020) and include 50 patients. Patients having thyroid nodules in B-mode ultrasound were included in the study. The nodules were then grouped into their respective categories based on ACR TI-RADS and further management was decided. Pathological correlation using Bethesda classification and cancer risk of each TIRADS category was determined in the follow-up period simultaneously.

**RESULTS:** All the 6 nodules classified under the TIRADS 5 category were found to be malignant while none of the TIRADS 2 nodules out of 29 were malignant i.e. Bethesda IV or higher. The risk of malignancy for ACR TI-RADS categories 1, 2, 3, 4 and 5 was 0, 14.3, 62.5 and 100%, respectively. The risk of cancer in our study is almost comparable to other prominent studies.

**CONCLUSION:** ACR based TIRADS classification is reliable in predicting thyroid malignancy.

### INTRODUCTION:

Newly detected thyroid lesions during the radiographic study for nonthyroid diseases are called "thyroid incidentalomas."<sup>[1]</sup> The prevalence rate of thyroid nodules are generally subject to the identification method. The prevalence rate is between 4 to 7% by palpation<sup>[2,3]</sup> whereas by using high-resolution ultrasound it ranges from 15 to 46%, in general population.<sup>[4,6]</sup> The diagnosis of incidentally detected thyroid nodules is increasing because of the copious utilization of ultrasound and the expanded access to cytology examination through fine-needle yearning cytology (FNAC) guided by ultrasound.<sup>[6]</sup> Even though the prevalence of thyroid incidentalomas during FDG-PET imaging is 2.2 -2.3%<sup>[7,8]</sup> but the risk of malignancy is as high as 26.7%<sup>[7]</sup> done for metastasis work-up of cancer patients<sup>[9]</sup> and screening of cancer in healthy individuals.<sup>[10,11]</sup> The possibility of malignancy is the main concern for the assessment of thyroid nodules and there are wide variations in the revealed extent of danger among the clinically or then again radiologically recognized thyroid nodules.<sup>[12]</sup>

According to The American Thyroid Association, thyroid nodule is defined as "a discrete lesion within the thyroid gland, radiologically distinct from surrounding thyroid parenchyma."<sup>[13]</sup> The incidence of thyroid nodules is almost four times higher in females than males<sup>[3]</sup> and this gender disparity is because of both estrogen and progesterone influence.<sup>[14]</sup>

### THYROID IMAGING REPORTING AND DATA SYSTEM (TI-RADS)

The Thyroid Imaging and Reporting System (TIRADS) was

proposed similar to the BIRADS classification. It was proposed by Horvath et al.,<sup>[15]</sup> the classification is used to differentiate thyroid swellings into benign or malignant and to allow for a better selection of thyroid nodules undergoing FNAC. They proposed ten ultrasound patterns and TIRADS 2-6 for nodules.

### AMERICAN COLLEGE OF RADIOLOGY (ACR) THYROID IMAGING REPORTING AND DATA SYSTEM (TI-RADS)

ACR TI-RADS proposed a risk stratification system in 2017 with an aim to provide a better selection of thyroid nodules for the practitioners to determine further management based on their US appearance. Nodules are grouped into their respective TIRADS category based on their composition ©, echogenicity (E), shape (S), margin (M), and echogenic foci (F), in where each individual category is assigned 0-3 score, final TIRADS category is based on the sum of the score of each category.<sup>[16,17]</sup>

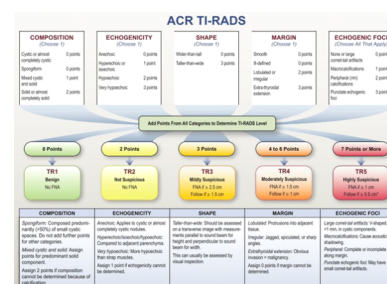


Figure 1: The 2017 ACR TI-RADS system.<sup>[16]</sup>

MATERIALS AND METHODS  
 STUDY DESIGN

Prospective study design. Duration of study: 1 year (January 2019–January 2020).

INCLUSION CRITERIA

Patients who have thyroid nodules in B-mode ultrasound.

EXCLUSION CRITERIA

Normal thyroid scans, completely cystic/anechoic nodules and proven cases of thyroid malignancy were not included in this study.

MATERIALS

High-resolution B-mode ultrasound is done using GE VOLUSON E6 with a high-frequency probe (9 Mhz). FNAC reports (follow-up).

SAMPLE SIZE

A total of 50 patients were included in the study.

SAMPLING METHOD

The study included all the study subjects, who satisfied the inclusion and exclusion criteria, hence no sampling was done.

PROCEDURE

The patient is made to lie supine with the neck in a mild extension position, done by placing a pillow/ rolled towel below the patient's upper back. The ultrasound examination starts with B-mode to image the thyroid and the neck. The thyroid nodules, if present, are staged according to ACR TIRADS. Then FNAC results are followed up for the Bethesda staging.

DATA COLLECTION METHODS

Data were collected for the study, using a structured case report form and from the history, clinical examination, and the investigation reports of the study participants.

Table 1: Thyroid imaging reporting and data system (TIRADS) and Bethesda correlation

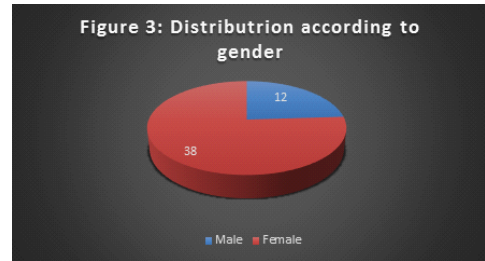
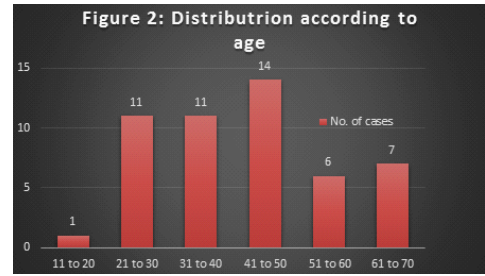
	Bethesda 1	Bethesda 2	Bethesda 3	Bethesda 4	Bethesda 5	Bethesda 6	Total
<b>TIRADS 2</b>	-	29	-	-	-	-	29
<b>TIRADS 3</b>	-	4	2	1	-	-	7
<b>TIRADS 4</b>	-	3	-	3	1	1	8
<b>TIRADS 5</b>	-	-	-	2	3	1	6
<b>Total</b>	-	36	2	6	4	2	50

- 12 out of 50 nodules were proven to be malignant on invasive tests.
- Out of the 29 TIRADS 2 nodules, none were found to be malignant i.e. Bethesda IV/V.
- Among the 7 TIRADS 3 nodules, 4 were in Bethesda II, 2 in Bethesda III and 1 in Bethesda IV i.e. only one turned out to be malignant.
- Out of 8 nodules that were suspicious and classified under TIRADS 4, 3 nodules turned out to be benign on Bethesda classification.
- All the 6 nodules classified under TIRADS 5 were found to be malignant on Bethesda classification.
- Among all malignant nodules, the percentage of malignant nodules classified as TIRADS 2 were 0%, TIRADS 3 were 8.3%, TIRADS 4 were 41.6% and TIRADS 5 were 50%.

TIRADS scores 4 and 5 were considered positive for malignancy, while scores 1–3 were considered negative for malignancy. Cross-tabulation of TIRADS and Bethesda was prepared [Table 2]. Data were analyzed by the Chi-square test or Fisher's exact test for categorical variables of benign and malignant nodules.

RESULTS

A total of 50 patients were included in this study, out of which the maximum number of cases were found in and around the third-fifth decade of life i.e. approximately 70% (36 patients) [Figure 2]. Females constitute about 76% (38 patients) of total cases [Figure 3].



Out of the 50 nodules, 29 were categorized under TIRADS 2, 7 were classified under TIRADS 3, 8 were classified under TIRADS 4, and 6 were classified under TIRADS 5. This means that most of the nodules fall under the TIRADS II classification, accounting for 58% of the total nodules detected on ultrasound. Similarly, 72% (36 nodules) of the nodules turn out to be Bethesda II on invasive tests. The nodules classified as Bethesda I, II and III were considered benign, and those nodules classified as Bethesda IV–VI were considered malignant. The results we obtained have been tabulated below in Table 1.

Table 2: TIRADS classification and FNAC results cross-tabulations

TIRADS	FNAC RESULTS		Total
	POSITIVE	NEGATIVE	
<b>POSITIVE</b>	11 (22%)	3 (6%)	14 (28%)
<b>NEGATIVE</b>	1 (2%)	35 (70%)	36 (72%)
<b>Total</b>	12 (24%)	38 (76%)	50 (100%)

We derived at 91.6% sensitivity, 92% specificity, 78.5% PPV, 97.2% NPV and accuracy of 92% for our study. Association was found to be significant between the TIRADS and Bethesda system of classification (p-value < 0.00001).

On comparing TIRADS result with the Bethesda system of classification, the cancer risk for TIRADS 2 was 0%, TIRADS 3 was 14.3%, TIRADS 4 was 62.5%, and TIRADS 5 was 100%.

FNAC RESULTS

Adenomatoid nodule, colloid nodule, papillary, follicular carcinoma and hurtle cell neoplasm of thyroid contributed 12, 58, 20, 8, and 2%, respectively.

DISCUSSION

Several risk stratification systems have been proposed in the past based on sonographic features for thyroid lesions, with a

structure modeled off BI-RADS. Due to the low correlation between the ultrasound reports and FNAC results or trouble in the reproducibility of various classification systems proposed, a general understanding has not been set up.<sup>[18]</sup> Various individual research groups have proposed initial interactions like American College of Radiology (ACR TI-RADS), European Thyroid Association (EU TI-RADS) and Korean Society of Thyroid Radiology (K TI-RADS), none of which gain widespread use.

At the end of our study, we have determined the accompanying outcomes utilizing sonological elements of ACR-TIRADS scoring of the nodules. The malignancy risk was 0% for TIRADS 1 and TIRADS 2 in our study while the risk of cancer for TIRADS 3, TIRADS 4, and TIRADS 5 were 14.3, 62.5, and 100%, respectively.

Among the classifications proposed from all over the world, Horvath et al. projected a malignancy risk of 0% in TIRADS 2, 3.4% in TIRADS 3, 10–80% in TIRADS 4, and 87% in TIRADS 5.<sup>[19]</sup>

Kwak et al.<sup>[19]</sup> retrospectively examined thyroid nodules in ultrasound and FNA using five sonological criteria to propose a TIRADS classification. They estimated a malignancy risk of 0% for TIRADS 2, 1.7% for TIRADS 3, a risk of 3.3–72.4% for TIRADS 4, and 87.5% for TIRADS 5.

Moifo et al.<sup>[20]</sup> conducted a cross-sectional study to decide the

reliability of Russ' modified TIRADS classification in predicting thyroid malignancy. The malignancy risk was 0% for TIRADS 2, 2.2% for TIRADS 3, 5.9–57.9% for TIRADS 4, and 100% for TIRADS 5.

According to a few studies from Indian literature, a prospective study by Anuradha et al.<sup>[21]</sup> to assess the positive predictive value (PPV) observed that PPV for malignancy was 6.6 for TIRADS 2, 32% for TIRADS 3, 36% for TIRADS 4A, 64% for TIRADS 4B, 59% for TIRADS 4C, and 91% for TIRADS 5 category.

Another prospective study by Srinivas et al.,<sup>[22]</sup> it was concluded that the risk of malignancy for TIRADS categories 1, 2, 3, 4A, 4B, 4C, and 5 was 0, 0, 0.64, 4.76, 66.67, 83.33, and 100%, respectively.

In a prospective study on 184 patients by Periakaruppan et al.,<sup>[22]</sup> the risk of malignancy for TIRADS categories 1, 2, 3, 4 and 5 was 0, 2.2, 38.5, and 77.8%, respectively. The malignancy risk for patients classified under TIRADS 4 was estimated at 17.5 times and those classified under TIRADS 5 were estimated at 35.4 times the risk for those rated as 3.

Our results are almost comparable to the other studies by Horvath et al., Kwak et al., Moifo et al., and three other studies based on the Indian population [Table 3].

**Table 3: Study comparison (Malignancy risk)**

	Our study	Periakaruppan et al.	Horvath et al.	Kwak et al.	Moifa et al.	Srinivas et al.
TIRADS 1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TIRADS 2	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TIRADS 3	14.30%	2.20%	14.10%	1.70%	2.20%	0.64%
TIRADS 4	62.50%	38.50%	45%	3.3%-72.4%	5.9%-57.9%	4.7%-83.3%
TIRADS 5	100%	77.80%	89.60%	87.50%	100%	100%

## Images

**Figure 4: - ACRTI-RADS category: Tr1**

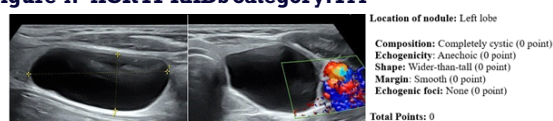


Figure 4: Sagittal and transverse sonogram of the left lobe of thyroid in a 39-year female

**Figure 5: - ACRTI-RADS category: Tr2**



Figure 5: Sagittal and transverse sonogram of the left lobe of thyroid in a 56-year female

**Figure 6: - ACRTI-RADS category: Tr3**

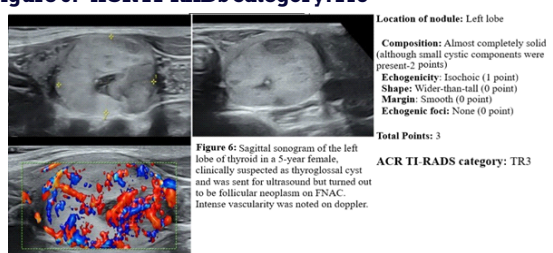


Figure 6: Sagittal sonogram of the left lobe of thyroid in a 5-year female, clinically suspected as thyroglossal cyst and was sent for ultrasound but turned out to be follicular neoplasm on FNAC. Intense vascularity was noted on doppler.

**Figure 7: - ACRTI-RADS category: Tr4**

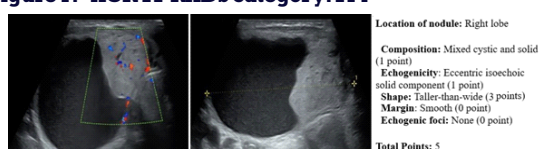


Figure 7: Sagittal and transverse sonogram of the right lobe of thyroid in a 37-year female

**Figure 8: - ACRTI-RADS category: Tr5**



Figure 8: Sagittal sonogram of the right lobe of thyroid in a 39-year female, when followed up with FNAC turned out to be papillary carcinoma.

## CONCLUSION:

ACR based TIRADS classification is reliable in predicting malignancy of focal thyroid nodule and further helps in segregating patients who require follow up with ultrasound or with FNAC. In our study, there was a significant relationship between ACR based TIRADS ultrasound classification system & Bethesda cytology.

## REFERENCES

1. Tan, G. H. (1997). Thyroid Incidentalomas: Management Approaches to Nonpalpable Nodules Discovered Incidentally on Thyroid Imaging. *Annals of Internal Medicine*, 126(3), 226. doi:10.7326/0003-4819-126-3-199702010-00009.
2. M.D, Peter & Cooper, D & Daniels, Gilbert & Ladenson, P & Greenspan, Francis & Levy, Elliot & Braverman, L & Clark, O & McDougall, I & Ain, Kenneth & Dorfman, S. (1996). Treatment guidelines for patients with thyroid nodules and well-differentiated thyroid cancer. American Thyroid Association. *Archives of internal medicine*. 156. 2165-72. 10.1001/archint.156.11.2165.
3. Desforges, J. F., & Mazzaferri, E. L. (1993). Management of a Solitary Thyroid Nodule. *New England Journal of Medicine*, 328(8), 553–559. doi:10.1056/n ejm199302253280807.
4. Brander, A., Viikinkoski, P., Nickels, J., & Kivisaari, L. (1991). Thyroid gland: US screening in a random adult population. *Radiology*, 181(3), 683–687. doi:10.1148/radiology.181.3.1947082.
5. Ezzat, S, Sarti DA, Cain DR, Braunstein GD. Thyroid Incidentalomas: Prevalence by Palpation and Ultrasonography. *Arch Intern Med*. 1994;154(16):1838– 184 0. doi:10.1001/archinte.1994.00420160075010.
6. Pazaitou-Panayiotou, K., Capezone, M., & Pacini, F. (2007). Clinical Features and Therapeutic Implication of Papillary Thyroid Microcarcinoma. *Thyroid*, 17(11), 1085–1092. doi:10.1089/thy.2007.0005.
7. Kang KW, Kim SK, Kang HS, et al. Prevalence and risk of cancer of focal thyroid incidentaloma identified by 18F-fluorodeoxyglucose positron emission tomography for metastasis evaluation and cancer screening in healthy



- subjects. *J Clin Endocrinol Metab.* 2003;88(9):4100-4104. doi:10.1 2 10/jc.2003-030465.
8. Cohen MS, Arslan N, Dehdashti F, Doherty GM, Lairmore TC, Brunt LM, Moley JF 2001 Risk of malignancy in thyroid incidentalomas identified by fluorodeoxyglucose-positron emission tomography. *Surgery* 130:941-946.
9. Strauss L, Conti PS 1991 The application of PET in clinical oncology. *J Nucl Med* 32:623-648.
10. Yasuda S, Ide M, Fujii H, Nakahara T, Mochizuki Y, Takahashi W, Shiohara A 2000 Application of positron emission tomography imaging to cancer screening. *Br J Cancer* 83:1607-1611.
11. Kao C, Kwan AS, Kwan JK, Chow M 2001 The role of 18F-fluorodeoxyglucose positron emission tomography in cancer screening: a preliminary report. *Oncol Rep* 8:1145-1148.
12. Periakaruppan G, Seshadri K, Vignesh Krishna GM, Mandava R, Sai V, Rajendiran S. Correlation between ultrasound-based TIRADS and Bethesda system for reporting thyroid cytopathology: 2-year experience at a tertiary care center in India. *Indian J Endocr Metab* 2018;22:651-5. DOI: 10.4103 /ijem.IJEM\_27\_18.
13. American Thyroid Association (ATA) Guidelines Taskforce on Thyroid Nodules and Differentiated Thyroid Cancer, Cooper DS, Doherty GM, et al. Revised American Thyroid Association management guidelines for patients with thyroid nodules and differentiated thyroid cancer [published correction appears in *Thyroid*. 2010 Aug;20(8):942. Hauger, Bryan R [corrected to Haugen, Bryan R]] [published correction appears in *Thyroid*. 2010 Jun;20(6):674-5]. *Thyroid*. 2009;19(11):1167-1214. doi:10.1089/ thy. 200 9.0110.
14. Kung AW, Chau MT, Lao TT, Tam SC, Low LC. The effect of pregnancy on thyroid nodule formation. *J Clin Endocrinol Metab.* 2002;87(3):1010-1014. doi:10.1 210/jcem.87.3.8285.
15. Horvath E, Majlis S, Rossi R, et al. An ultrasonogram reporting system for thyroid nodules stratifying cancer risk for clinical management. *J Clin Endocrinol Metab.* 2009;94(5):1748-1751. doi:10.1210/jc.2008-1724.
16. Tessler FN, Middleton WD, Grant EG, et al. ACR thyroid imaging, reporting and data system (TI-RADS): white paper of the ACRTI-RADS committee. *J Am Coll Radiol* 2017;14(5):587-595.
17. Tessler, F. N., Middleton, W. D., & Grant, E. G. (2018). *Thyroid Imaging Reporting and Data System (TI-RADS): A User's Guide*. *Radiology*, 287(1), 29-36. doi:10.1148/radiol.2017171240.
18. Paschke R, Hegedüs L, Alexander E, Valcavi R, Papini E, Gharib H. Thyroid nodule guidelines: agreement, disagreement and need for future research. *Nat Rev Endocrinol.* 2011;7(6):354-361. doi:10.1038/nrendo.2011.1.
19. Kwak JY, Han KH, Yoon JH, et al. Thyroid imaging reporting and data system for US features of nodules: a step in establishing better stratification of cancer risk. *Radiology.* 2011;260(3):892-899. doi:10.1148/radiol.11110206.
20. B. Moifo, E. Takoeta, J. Tambe, F. Blanc and J. Fotsin, "Reliability of Thyroid Imaging Reporting and Data System (TI-RADS) Classification in Differentiating Benign from Malignant Thyroid Nodules," *Open Journal of Radiology*, Vol. 3 No. 3, 2013, pp. 103-107. doi: 10.4236/ojrad.2013.33016.
21. Chandramohan A, Khurana A, Pushpa BT, Manipadam MT, Naik D, Thomas N, et al. Is TIRADS a practical and accurate system for use in daily clinical practice?. *Indian J Radiol Imaging* 2016;26:145-52. doi:10.4103/0971-3026.178367.
22. Srinivas MN, Amogh VN, Gautam MS, Prathyusha IS, Vikram NR, Retnam MK, et al. A Prospective Study to Evaluate the Reliability of Thyroid Imaging Reporting and Data System in Differentiation between Benign and Malignant Thyroid Lesions. *J Clin Imaging Sci* 2016;6:5. DOI: 10.4103/2156-7514.177551.