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Research Article

Clinical Cancer and Oncology

Pankaj Sharma *

Evaluating Thyroid Nodules: Combined ACR TIRADS and Colour Doppler for Improved Diagnosis

Pankaj Sharma [1*], Bhavya Sharma [2], Ravi Kant [3], Ashok Singh [4], and Udit Chauhan [5].

[1] Additional Professor, Department of Radiodiagnosis, All India Institute of Medical Sciences, Rishikesh, Uttarakhand, INDIA.

[2] Junior Resident, Department of Radiodiagnosis, All India Institute of Medical Sciences, Rishikesh, Uttarakhand, INDIA.

[3] Professor, Department of General Medicine, All India Institute of Medical Sciences, Rishikesh, Uttarakhand, INDIA.

[4] Additional Professor, Department of Pathology, All India Institute of Medical Sciences, Rishikesh, Uttarakhand, INDIA.

[5] Additional Professor, Department of Radiodiagnosis, All India Institute of Medical Sciences, Rishikesh, Uttarakhand, INDIA.

***Corresponding Author: Pankaj Sharma,** Additional Professor, Department of Radiodiagnosis, All India Institute of Medical Sciences, Rishikesh, Uttarakhand, INDIA.

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ABSTRACT

Background:

Our study is first prospective study from Himalayan belt of North India, wherein we have tried to evaluate palpable or clinically suspicious thyroid nodules using combined ACR TIRADS and Colour Doppler, along with cyto-pathological correlation.

Material and Method:

120 patients underwent HR-USG evaluation of palpable or clinically suspicious thyroid nodule, using ACR TIRADS scoring system, over a period of 18 months. The final ACR TIRADS score was prospectively correlated with cyto-pathological diagnosis.

Result and Observation:

ACR TIRADS had sensitivity of 92.0%, specificity of 77.9%, positive predictive value of 52.3%, negative predictive value of 97.4%, and diagnostic accuracy of 80.8%, for differentiating benign from malignant thyroid nodule. Increased central vascularity on colour doppler had sensitivity of 80.8%, specificity of 83.2%, positive predictive value of 55.6%, negative predictive value of 94.0%, and diagnostic accuracy of 82.5%, for differentiating benign from malignant thyroid nodule.

Conclusion:

High resolution sonography plays an important role in the stratification of at risk nodules requiring further evaluation, and ACR TIRADS should be routinely used in reporting of thyroid nodules. Colour doppler can play a role in adjunction with gray scale ultrasonography in diagnosis of malignant thyroid nodules, specially when using ACR TIRADS for patient categorization and management. Moreover, ultrasonography can help in reducing unnecessary FNAC of benign thyroid nodules.

KEYWORDS:

high resolution, sonography, colour doppler, fine needle aspiration cytology, vascularity

INTRODUCTION

Our study is first prospective study from Himalayan belt of North India, wherein we have tried to evaluate palpable or clinically suspicious thyroid nodules using combined ACR TIRADS and Colour Doppler, along with cyto-pathological correlation

MATERIAL AND METHOD

120 patients with age more than 18 years, were

referred to Department of Radiodiagnosis for HR-USG evaluation of palpable or clinically suspicious thyroid nodule. These patients were recruited over a period of 18 months, and all of them gave written informed consent.

Exclusion criteria were as follows:

a) Patient with ongoing treatment for thyroid malignancy,
b) Patient with past history of treatment for thyroid malignancy,
c) Patient with indeterminate & inconclusive results on FNAC,
d) Patient who didn't gave written informed consent.

Technique:

All thyroid nodules were evaluated on Gray scale and Colour Doppler, using high frequency linear USG probe (7–12 MHz). The characteristics of each nodule was used to assign ACR TIRADS score. The final ACR TIRADS score was prospectively correlated with cytological diagnosis. Color Doppler examination was performed by using standard equipment settings for thyroid gland. Doppler amplification was set to a level that normal thyroid tissue didn't display any noise, and was just under the level for appearance of random noise.

Thyroid nodule Colour Doppler vascularity was categorized into four categories:

a) Increased central vascularity,
b) Increased peripheral vascularity,
c) Increased central and peripheral vascularity,
d) Absent increased central/peripheral vascularity.

FNAC was done from palpable or clinically suspicious thyroid nodule (Figure 1), and assessed using The Bethesda System for Reporting Thyroid Cytopathology (TBSRTC), after fulfilling the adequacy criteria.1 Final diagnosis in all cases diagnosed as Follicular neoplasm on FNAC, was based on histopathological diagnosis after surgical resection.

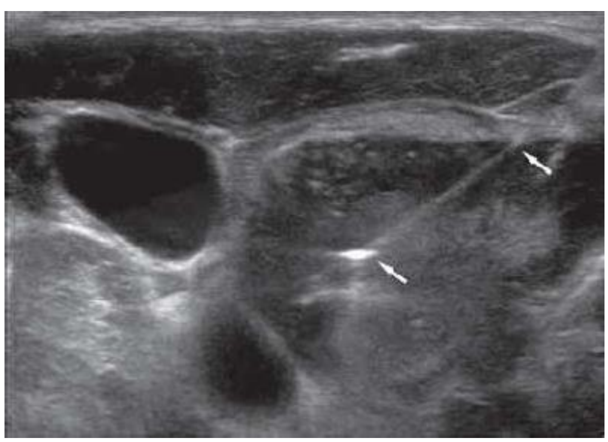

Figure 1 : FNA cytology of thyroid nodule with echogenic needle in long axis

STATISTICAL ANALYSIS

Microsoft Excel spread sheet was used to enter all the data. All precautions were taken to make sure that there was no error in data entry. The data was analysed using SPSS statistical software. There was a statistically significant difference if the p-value was less than 0.05

OBSERVATION AND RESULT

120 patients were included in study population. 28(23.33%) patients were in age group of 21– 30 years; 27(22.50%) patients were in age group of 31– 40 years; 24(20.00%) patients were in age group of 41– 50 years; 19(15.83%) patients were in age group of 51– 60 years; 16(13.33%) patients were in age group of 61– 70 years; 4(3.30%) patients were in age group less than 20 years; and 2 (1.66%) patients were in age group of 71–80 years (Table 1). 19(15.8%) patients were male; and 101(84.2%) patients were female.

Age	Frequency	Percentage
≤20 Years	**4**	**3.30%**
21-30 Years	**28**	**23.33%**
31-40 Years	**27**	**22.50%**
41-50 Years	**24**	**20.00%**
51-60 Years	**19**	**15.83%**
61-70 Years	**16**	**13.33%**
71-80 Years	**2**	**1.66%**
Total	**120**	**100.0%**

Table 1 : Distributaion of patients in terms of age (n=120)

Thyroid nodules varied in size from 4 mm to 87 mm, with mean nodule size being 24.98 ± 14.89 (Standard deviation) mm. 74(16.70%) thyroid nodules measured less than/equal to 25 mm; and 46(38.30%) thyroid nodules measured more than 25 mm in longest dimension. 71(59.20%) nodules involved right lobe of thyroid; 47(39.20%) nodules involved left lobe of thyroid; and 2(1.70%) nodules involved thyroid isthmus (Table 2).

Lobe Involved	Frequency	Percentage
Right	71	59.2%
Left	47	39.2%
Isthmus	2	1.7%
Total	120	100.0%

Table 2 : Distribution of patients in terms of involvement of thyroid lobe (n=120)

According to vascularity on Colour Doppler (Figure 2,3,4,5 and Table 3); 73(60.80%) patients showed absent increased central/peripheral vascularity; 24(20.00%) patients showed increased central vascularity; 12(10.00%) patients showed increased central as well as peripheral vascularity; and 11(9.20%) patients showed increased peripheral vascularity.

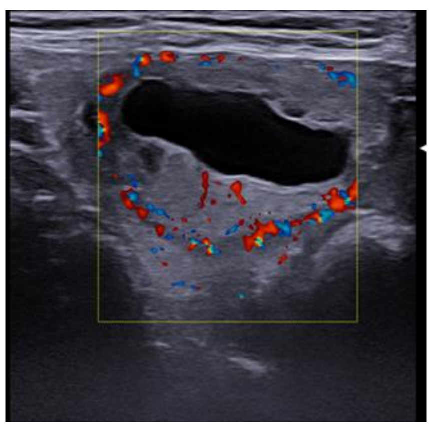

Figure 2 : Thyroid nodule on Colour Doppler showing increased peripheral vascularity.

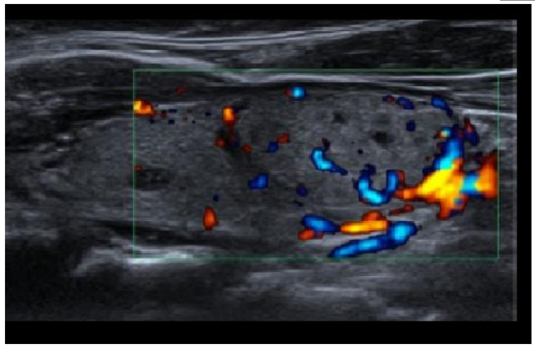

Figure 3 : Thyroid nodule on Colour Doppler showing increased central vascularity.

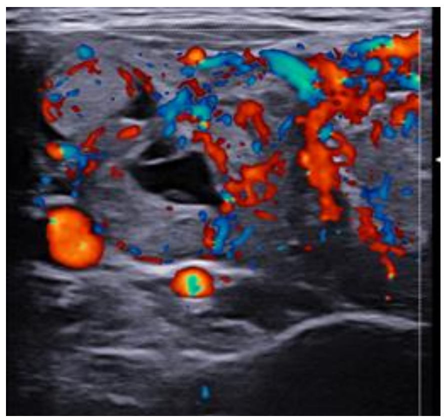

Figure 4 : Thyroid nodule on Colour Doppler showing increased central as well as peripheral vascularity.

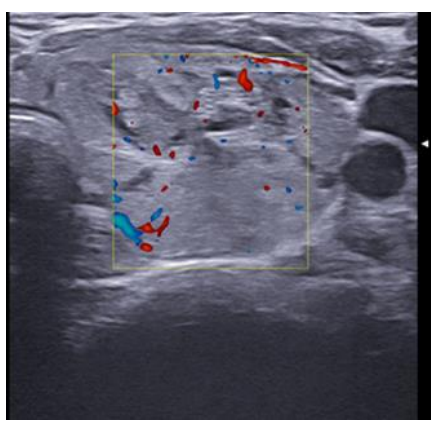

Figure 5 : Thyroid nodule on Colour Doppler showing absent increased central/peripheral vascularity.

Vascularity on Colour Doppler	Frequency	Percentage
Absent increased central/peripheral vascularity	73	60.8%
Increased peripheral vascularity	11	9.2%
Increased central vascularity	24	20.0%
Increased central as well as peripheral vascularity	12	10.0%
Total	120	100.0%

Table 3 : Distributaion of patients according to vascularity on Colour Doppler (n = 120)

According to ACR TIRADS scoring system (Table 4); 40(33.30%) patients had T3 score; 36(30.00%) patients had T2 score; 28(23.30%) patients had T4 score; and 16(13.30%) patients had T5 score.

TIRADS	Frequency	Percentage
TR2	36	30.0%
TR3	40	33.3%
TR4	28	23.3%
TR5	16	13.3%
Total	120	100.0%

Table 4: Distributaion of patients according to ACR TIRADS scoring system (n = 120)

According to cytological diagnosis after fine needle aspiration cytology (Table 5); 47 (39.2%) patients had colloid goitre; 24 (20%) patients had adenomatous goitre; 18 (15%) patients had papillary carcinoma; 8 (6.7%) patients had lymphocytic thyroiditis; 6 (5.0%) patients had reactive lymphoid hyperplasia; 5 (4.2%) patients had reactive follicular carcinoma; 3 (2.5%) patients had autoimmune thyroiditis; 3 (2.5%) patients had granulomatous inflammation; 2 (1.7%) patients had hurthle cell nodule; and 2 (1.7%) patients had medullary carcinoma. According to cytological diagnosis after fine needle aspiration cytology (Table 6); 95 (79.2%) patients had benign thyroid disease; and 25 (20.8%) patients had malignant thyroid disease.

Cyto-pathological diagnosis	Frequency	Percentage
Colloid Goitre	47	39.2%
Adenomatous Goitre	24	20.0%
Papillary Carcinoma	18	15.0%
Lymphocytic Thyroiditis	8	6.7%
Reactive Lymphoid Hyperplasia	6	5.0%
Follicular Carcinoma	5	4.2%
Autoimmune Thyroiditis	3	2.5%
Granulomatous Inflammation	3	2.5%
Hurthle Cell Nodule	2	1.7%
Medullary Carcinoma	2	1.7%
Total	120	100.0%

Table 5: Distributaion of patients after cytopathological diagnosis (n = 120)

Cytological diagnosis	Frequency	Percentage
Benign	95	79.17%
Malignant	25	20.83%
Total	120	100.0%

Table 6: Distributaion of patients in terms of cytological diagnosis after fine needle aspiration cytology (n = 120)

Table 7 shows comparison of sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of various parameters. TIRADS had sensitivity of 92.0%, specificity of 77.9%, positive predictive value of 52.3%, negative predictive value of 97.4%, and diagnostic accuracy of 80.8%, for differentiating benign from malignant thyroid nodule. Increased central vascularity on colour doppler had sensitivity of 80.8%, specificity of 83.2%, positive predictive value of 55.6%, negative predictive value of 94.0%, and diagnostic accuracy of 82.5%, for differentiating benign from malignant thyroid nodule.

Variable	Sensitivity	Specificity	PPV	NPV	Diagnostic Accuracy
Size (mm) (Cut off: 27 by ROC)	52.0% (31-72)	66.3% (56-76)	28.9% (16-44)	84.0% (74-91)	63.3% (54-72)
Size	52.0% (31-72)	65.3% (55-75)	28.3% (16-43)	83.8% (73-91)	62.5% (53-71)
Increased central vascularity on Color Doppler	80.0% (59-93)	83.2% (74-90)	55.6% (38-72)	94.0% (87-98)	82.5% (75-89)
TIRADS	92.0% (74-99)	77.9% (68-86)	52.3% (37-68)	97.4% (91-100)	80.8% (73-87)

Table 7: Comparison of sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of various parameters

Raw data (e.g., imaging datasets, FNAC results, statistical analysis files) are available with authors, and authors can be contacted in this regard.

DISCUSSION

120 patients were included in our study for evaluation of thyroid nodule : clinically symptomatic patient with no palpable thyroid nodule; or clinically symptomatic patient with palpable thyroid nodule; or clinically suspected patient with no specific symptom. Thyroid nodules were observed to be more common in female population, suggestive of female predominance, comprising 84.2% of total study

population.

In present study, highest number of cases were reported in 21-30 years age group (23.33%), followed by 31-40 years age group (22.50%). Malignant thyroid nodules were commonly of size more than 1 cm, and solitary (66.6%) in nature.

Our study has shown malignancy risk as 2.8%, 2.5%, 35.7% and 81.2% for TR2, TR3, TR4 and TR5 thyroid nodules respectively. Our results are in concordance with previous studies, with 92% sensitivity, 77% specificity, 52.3% positive predictive value, and 97.4% negative predictive value, when we did correlation of TIRADS scoring system with histopathology. Table 8 shows review of literature, with inference that ACR TIRADS is useful scoring system for evaluation of thyroid nodules, in comparison to other TIRADS scoring system.

Torshizian A, et al. Retrospective. 571 thyroid nodules. 2023.	**The AUC, sensitivity, specificity, positive predictive value, and negative predictive value were 0.691, 49.2%, 84.9%, 29.6%, and 92.8% for ATA guideline, and 0.776, 72.3%, 79.2%, 30.9%, and 95.7%, for ACR TI-RADS, respectively. ACR TI-RADS was more sensitive ($p = 0.003$), while the ATA guideline was more specific ($p < 0.001$). Decision Curve Analysis demonstrated that the ACR TI-RADS provided a greater net benefit than the ATA guideline. In addition, the net reduction in unnecessary biopsies is higher for ACR TI-RADS than ATA guidelines.**
Jin Z, et al. Retrospective. 3438 thyroid nodules. 2023.	**C-TIRADS showed higher discrimination performance (AUROC, 0.857; AUPRC, 0.605) than ACR-TIRADS (AUROC, 0.844; AUPRC, 0.567) and EU-TIRADS (AUROC, 0.802; AUPRC, 0.455). C-TIRADS may be a clinically applicable tool to manage thyroid nodule which warrants thorough tests in other geographic settings.**
Cai Y, et al. Retrospective. 1228 thyroid nodules.	**The 2017 ACR-TIRADS had the highest diagnostic performance [area under the receiver operating characteristic curve (AUROC) 0.938], followed by the 2020 C-TIRADS (AUROC 0.933) and the 2015 ATA guidelines (AUROC 0.928).**

2023.	
Huang Hu, et al. Retrospective. 512 thyroid nodules. 2023.	**ACR TI-RADS and C-TIRADS systems had relatively high diagnostic efficacy for elderly thyroid cancer. The diagnostic efficacy between the two systems was not statistically significant. In addition, the two systems had high clinical practical values, while there is still a significant risk of missed diagnosis.**
Borges AP, et al. Retrospective. 665 thyroid nodules. 2023.	**The EU-TIRADS and ACR TI-RADS are both suitable to assess thyroid nodules and through risk stratification avoid unnecessary FNA. FNA was less performed using ACR TI-RADS, which was slightly more efficiency in excluding malignancy.**
Chen Q, et al. Retrospective. 1982 thyroid nodules. 2022.	**C-TIRADS has excellent performance in the malignancy risk stratification of thyroid nodules by the optimized cut-off value, which is comparable to that in K-TIRADS and ACR-TIRADS.**
Chen H, et al. Retrospective. 2000 thyroid nodules. 2021.	**The ACR TIRADS classification system is less invasive and can identify suspicious nodules more accurately than that of ATA and AACE/ACE/AME.**
Li Wei, et al.	**ACR TI-RADS showed favorable sensitivity and moderate specificity in risk**

Systemic Review and Meta-analysis. 2021.	**stratification of thyroid nodules. The use of ACR TI-RADS could avoid a large number of unnecessary biopsies, although at the cost of a slight decline in sensitivity.**
Gao L, et al. Retrospective. 2544 thyroid nodules. 2019.	**KWAK-TIRADS and ATA guidelines provide a better diagnostic efficiency than ACR TI-RADS. The TIRADS (KWAK-TIRADS and ACR TI-RADS) category and ATA guidelines perform better in differentiating nodules >1 cm than nodules ≤1 cm. KWAK-TIRADS perform better in differentiating nodules >1 cm than other methods.**
Our study	**High resolution sonography plays an important role in the stratification of at risk nodules requiring further evaluation, and ACR TIRADS should be routinely used in reporting of thyroid nodules. Colour doppler can play a role in adjunction with gray scale ultrasonography in diagnosis of malignant thyroid nodules, specially when using ACR TIRADS for patient categorization and management. Moreover, ultrasonography can help in reducing unnecessary FNAC of benign thyroid nodules.**

Table 8: Review of Literature[2-10]

In our series, 73 out of 120 thyroid nodules showed absent increased central/peripheral vascularity; 95.9% of which were found to be benign in nature. 12 out of 120 thyroid nodules showed increased central as well as peripheral blood vascularity; 58% of which were found to be benign in nature, and 41.7% of which were found to be malignant in nature. 20 out of 25 malignant thyroid nodule showed increased central blood vascularity. That means, in our study, 95% of benign thyroid nodules showed absent increased central/peripheral vascularity; while 80% of malignant thyroid nodules showed increased central vascularity.

Increased vascularity on colour doppler had sensitivity of 80.8%, specificity of 83.2%, positive predictive value of 55.6%, negative predictive value of 94.0%, and diagnostic accuracy of 82.5%, for differentiating benign from malignant thyroid nodule. P value was significant for differentiating benign from malignant thyroid nodule, for both increased central vascularity on colour Doppler, and TIRADS scoring system; when we did correlation with cytological diagnosis after FNAC.

According to cytological diagnosis after FNAC; 79.2% patients had benign thyroid disease, and 20.8% patients had malignant thyroid disease. Only exception was FNAC diagnosis of Follicular carcinoma, which was confirmed on histopathology after surgical resection. Our study highlights that TIRADS scoring system, alongwith Colour doppler findings, can be used for evaluation of thyroid nodules; with avoidance of invasive FNAC, especially in patients with absent increased central/peripheral vascularity, and TR2.

In our study, best predictor of malignancy in combination with ACR TIRADS categorization was : Increased central vascularity. We evaluated palpable or suspicious thyroid nodules using ACR TIRADS and Colour Doppler, but not using SMI quantification. Indeterminate nodules with no increased central vascularity on colour Doppler can be spared FNAC, if same results are found on multicentric studies, with inclusion of population from different geographical areas.

CONCLUSION

High resolution sonography plays an important role in the stratification of at risk nodules requiring further evaluation, and ACR TIRADS should be routinely used in reporting of thyroid nodules. Colour doppler can play a role in adjunction with gray scale ultrasonography in diagnosis of malignant thyroid nodules, specially when using ACR TIRADS for patient categorization and management. Moreover, ultrasonography can help in reducing unnecessary FNAC of benign thyroid nodules.

LIMITATIONS AND FUTURE DIRECTIONS

Main limitation of our study is that it is single center-based study, conducted in Himalayan belt of North India. Even though there are specific characters of benignity and malignancy on ultrasound, it may overlap in some cases which may lead to misdiagnosis. In such cases, histopathological diagnosis becomes of utmost importance. There may also be presence of inter-observer variation on ultrasound evaluation in our study. To reach meaningful conclusion, multi-centre trial should be done with inclusion of large cohort of patients, alongwith Artificial Intelligence based machine learning integration for thyroid nodule assessment, using both Colour Doppler and SMI Quantification.

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