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Original Research Article

Sonographic evaluation of thyroid nodule based on thyroid imaging reporting and data system classification and its correlation with fine needle aspiration cytology findings

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ABSTRACT

Background: Thyroid nodules, common clinical occurrences, often require diagnostic assessment. Ultrasonography (USG) is primary non-invasive method for detection, with advancing technology enhancing detection capabilities. Fine needle aspiration cytology (FNAC) remains standard but poses risks and expenses. American college of radiology-thyroid image reporting and data system (ACR-TIRADS), introduced in 2017, offers a systematic scoring system based on ultrasound features. This study aims to evaluate USG guided by ACR-TIRADS for accurate nodule classification.
Methods: A 1.5-year study at department of radio-diagnosis of BSMCH evaluated thyroid nodules using high-resolution USG based on ACR-TIRADS criteria, followed by FNAC for selected cases, comparing results for concordance.
Results: Out of 47 thyroid nodules evaluated, 19.1% were malignant and 80% benign. ACR-TIRADS demonstrated sensitivity, specificity, and accuracy of 66.7%, 87.8%, and 82.9%, respectively. Higher ACR-TIRADS categories correlated with an increased risk of malignancy. Suspicious USG features such as hypo-echogenicity, taller-than-wide shape, lobulated margin, and punctate echogenic foci exhibited significant predictive value for malignancy, with varying levels of sensitivity and specificity. Overall, USG parameters demonstrated notable accuracy in identifying malignant nodules.
Conclusions: ACR-TIRADS 2017 reliably predicts thyroid nodule malignancy, reducing unnecessary FNAC procedures, minimizing patient discomfort, and optimizing healthcare resources.

Keywords: USG, ACR- TIRADS, Thyroid nodules, FNAC, Benign, Malignant

INTRODUCTION

A "thyroid nodule" is a well-defined area of altered echogenicity within the thyroid gland that is radiologically distinct from the surrounding normal thyroid parenchyma.[1] Thyroid nodules are relatively common in the general population, with a prevalence of 4-8 % based on palpation alone and 19-67% based on ultrasound examination. Thyroid nodules are found in about 8.55 % of the population in India.[2] Thyroid carcinoma has become more common in recent decades as a result of significantly improved USG surveillance and USG-guided FNAC of thyroid nodules.

The majority of thyroid nodules are benign, but malignancy is found in about 5-15% of cases. High-risk features such as age, sex, radiation exposure history, family history and other factors should be evaluated further.[3-5] Thyroid nodules are very common in women. Despite this, men's nodules are more aggressive and have a higher risk of malignancy.[6] Thyroid lesions can be detected using ultrasound technology, even if they are as small as a few mm in size. FNAC is a critical tool for developing a rational approach to the clinical management of thyroid nodules and determining the appropriate surgical procedure when surgery is required. FNAC is the standard procedure for thyroid nodule diagnosis, but it is risky and expensive. For the initial assessment of thyroid nodules, ultrasound is a widely accepted imaging modality. Because it is the simplest, quickest, and least invasive method with the highest sensitivity, USG has taken a significant role in the early detection of thyroid nodules. There are well-established ultrasound findings that can differentiate benign and malignant thyroid nodules and there are several classification systems that categorise thyroid nodules according to the risk of malignancy.[7-18] Of the many classification systems TIRADS is a relatively simple and comprehensive system for stratifying thyroid nodules and accurately characterizing them to reduce the number of unnecessary painful aspiration and biopsy procedures. TIRADS can be easily adopted, similar to breast imaging-reporting and data system (BIRADS), which has been successfully used to assess breast lesions for several years. TIRADS classification systems include ACR-TIRADS, K-TIRADS, and EU-TIRADS. The ACR-TIRADS 2017 is a score-based system that distributes points for the composition, echogenicity, shape, margins and echogenic foci of thyroid nodules on ultrasound, making it simple and trustworthy. Each feature is scored from 0 to 3 points. The first four categories each have a single score derived from mutually exclusive choices, whereas the echogenic foci category can have multiple features. The total point of the nodule determines its risk level, which ranges from TR1 (benign) to TR5 (highly suspicious).

The TR level, along with the nodule's maximum diameter, determines whether a fine needle aspiration biopsy, a follow-up USG examination, or no further action is recommended. According to comparative studies, the ACR system has a sensitivity ranging 75-97% and a specificity ranging 53-76%, making it either the highest sensitivity and lowest specificity among compared systems, or to the contrary, highest specificity.[19] In two studies it was found that the ACR system had the best overall performance (measured by the area under the receiver operating characteristic curve or accuracy), resulting in fewer unnecessary fine needle aspirations (false positive rates).[20,21]

The use of ultrasound and cytological examination to stratify the risk of malignancy in people with thyroid nodules has been studied all over the world. Kwak et al proposed a TIRADS score based on a retrospective ultrasound and FNA analysis of thyroid nodules, using five ultrasound criteria that can be used during the evaluation.[17] According to a study done by Srinivas et al TIRADS categories 1, 2, 3, 4A, 4B, 4C and 5 had a risk of malignancy of 0%, 0%, 0.64%, 4.76%, 66.67%, 88.33%, and 100%, respectively.[22] In India, data on the sonographic classification of thyroid nodules based on ACR-TIRADS 2017 and their cytological correlation are limited. The present study was conducted to evaluate diagnostic accuracy of USG based on ACR-TIRADS differentiating benign and malignant nodules and in comparing the findings with results of FNAC taking the FNAC examination as the gold standard. With the help of ACR-TIRADS scoring system, if USG can predict malignancy accurately of a thyroid nodule, then FNAC can be done for the selected patients. Thus, patients with benign thyroid nodule based on ACR-TIRADS will be exempted from the invasive, painful and time-consuming procedure of FNAC. So, the purpose of this study was to determine the sensitivity, specificity and diagnostic accuracy of the ACR-TIRADS scoring system as a cost-effective tool for the evaluation and characterization of thyroid nodules, as well as its role in establishing diagnosis and thus treatment.

Objectives

Objectives were to assess of usefulness of USG in determining the nature of a thyroid nodule based on ACR-TIRADS classification and to correlate the USG findings with respective cytological findings.

METHODS

This prospective analytical study of cross-sectional design was carried out in department of radio-diagnosis and pathology of Bankura Sammilani medical college and hospital after receiving the necessary institutional ethical clearance, from June 2020 to November 2021.

As per the record 1-2 patients used to come for neck and thyroid ultrasound every week in the department of radio-diagnosis. In a total one-year period (i.e., 52 weeks) total no. of patients visited in Radio-diagnosis department would be around 50. So, the entire patients reporting to radio-diagnosis department was included in the study. So, as such no sampling method will be adopted in the study. So, the sample size was arbitrarily 50.

The same patient would be evaluated for USG (based on ACR-TIRADS), FNAC. So, one patient would act as his/her own control and therefore no separate control group was required for the proposed study.

Patient with secondary thyroid related disorder like drug/radiation induced hypo /hyper thyroidism, systemic or central nervous system related secondary thyroid involvement, patients with diffuse thyroid /neck swelling, ulcerated and fungating thyroid lesion, patient not capable of giving consent, patient not willing to participate in a study, nodules which were not differentiated by FNAC as benign or malignant were excluded from the study.

Study technique

Study techniques were-A) Interview, B) scrutiny of reports, C) clinical examination of thyroid, D) imaging investigation-USG: In this study, the high-resolution ultrasound device (5-12 MHz linear phased array transducer) at Bankura Sammilani medical college and hospital (BSMC and H), manufactured by GE under the model number LOGIQ P9, was utilized. Additionally, the Philips-manufactured HD7 (2.0.1) machine was employed. Patients were positioned supinely with slight hyperextension of the neck for examination. The thyroid gland was scanned both transversely and longitudinally. Nodular lesions were assessed based on their composition, echogenicity, shape, margin, and presence of echogenic foci. Subsequently, thyroid nodules were categorized into appropriate ACR-TIRADS 2017 classifications according to ultrasound findings. E) USG guided FNAC: During USG-guided FNAC, patients were positioned supinely with their necks slightly extended. Following lesion localization, the neck area was sterilized and draped in aseptic conditions. FNAC was conducted under USG guidance without the administration of local anesthesia. A 22- or 23-gauge needle, connected to a 10- or 20-ml syringe with a holder, was positioned just above the transducer. The needle tip was inserted perpendicularly to the neck, visible as a bright spot on the monitor, while with mixed solid cystic nodules, it was directed towards the solid portion. The FNAC procedure involved back-and-forth movements, with suction released before needle withdrawal. Needle movements were continuously monitored in real-time throughout the process. Aspirated material was collected, smeared, and fixed onto glass slides, then sent to the pathology department for cytological examination by a pathologist. The cytopathological findings (benign/malignant) were compared with sonographic results based on ACR-TIRADS.

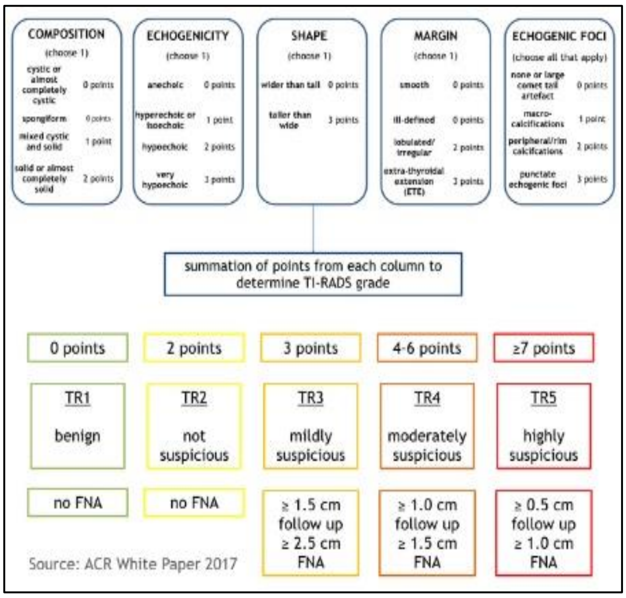

Figure 1: ACR-TIRADS 2017 scoring system.

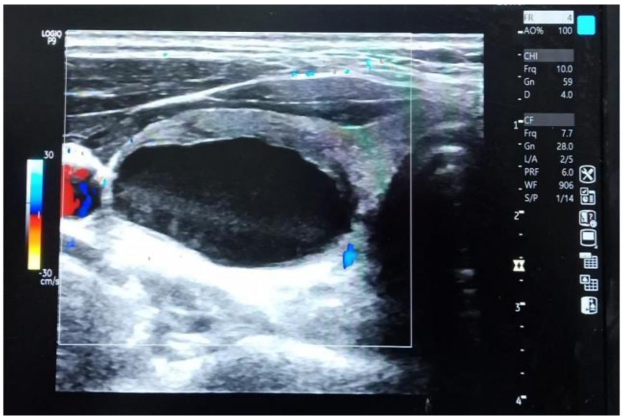

Figure 2: Cystic (0), anechoic (0), wider than tall (0), smooth margin (0), no calcific foci (0), TIRADS score: 0, TIRADS category 1 (colloid cyst).

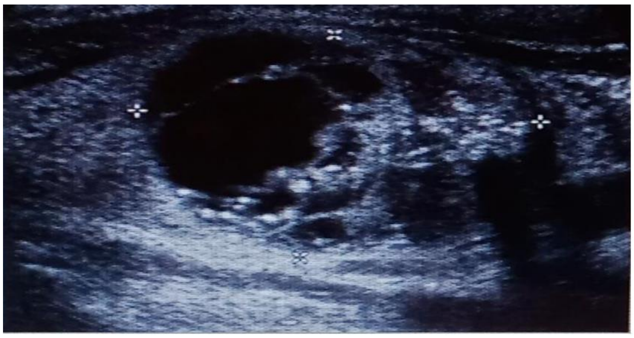

Figure 3: Mixed solid cystic (1), hypoechoic (2), wider than tall (0), smooth margin (0), punctate echogenic foci (3); TIRADS score 6, TIRADS category 4 (papillary carcinoma thyroid).

RESULTS

A total of 47 nodules were selected for the study between the time period of June 2020 to November 2021. Results of our investigation were evaluated using proportion and chi squared test. Level of significance was 0.05.

We compare p value with level of significance. If p<0.05, we reject the null hypothesis and accept the alternate hypothesis. If >0.05, we accept the null hypothesis.

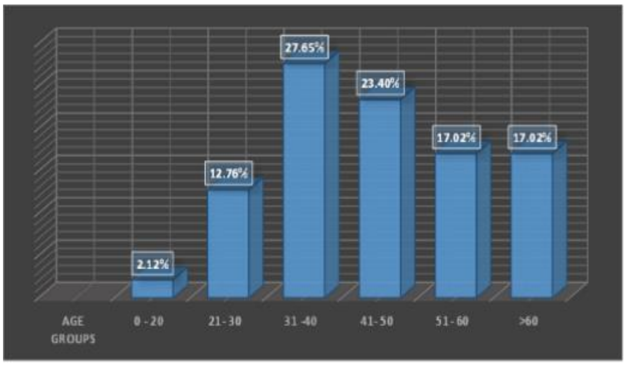

Figure 4: Age distribution.

Table 1: Sex distribution.

Gender	N
Male	14
Female	33
Total	47

Table 2: Comparison of risk of malignancy of ACR-TIRADS 2017 category.

ACR-TIRADS category	No. of benign nodules	No. of malignant lesions	Total	Risk of malignancy (%)
1	2	0	2	0
2	3	0	3	0
3	28	3	31	9.6
4	4	2	6	33.33
5	1	4	5	80

Table 3: Comparison of risk of malignancy for individual USG features included in ACR TIRADS 2017.

USG features		Benign	Malignant	Total	Risk of malignancy (%)
Composition	Cystic or predominantly cystic	2	0	2	0
	Spongiform	1	0	1	0
	Mixed solid -cystic	7	1	8	12
	Solid or predomonantly solid	28	8	36	22.2
Echogenicity	Anechoic	2	0	2	0
	Hyperechoic or isoechoic	33	3	36	8.3
	Hypoechoic	3	6	9	66.6
	Very hypoechoic	0	0	0	0
Shape	Wider than tall	37	5	42	11.9
	Tallr than wide	1	4	5	80
Margins	Smooth	35	4	39	10.2
	Ill-defined	2	1	3	33.3
	Lobulated/irregular	1	3	4	75
	Extra-thyroidal extension	0	1	1	100
Echogenic foci	None /comet tail artifact	28	4	32	12.5
	Macro-calcification	7	1	8	12.5
	Peripheral rim calcification	2	1	3	33.3
	Punctate echogenic foci	1	3	4	75

Table 4: Comparision of statistical results of ACR- TIRADS suspicious descriptors for predicting malignancy in thyroid nodules.

Ultrasound feature	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	PLR	NLR	Accuracy	P value
Solid composition	88.9	26.23	22.2	90.9	1.2	0.42	38.2	0.33
Hypo-echogenicity	66.67	92.1	66.6	92.1	8.3	0.36	87.2	0.000056
Taller than wide shape	44.44	97.4	80	88	14.6	0.58	87.2	0.000254
Lobulated/irregular margins	33.3	97.3	75	86	11	0.69	85.1	0.00299
Extrathyroidal extension	11.1	100	100	82.6	Infinity	0.89	82.9	0.03
Punctate echogenic foci	33.33	97.3	75.0	86.04	11	0.69	74.47	0.0029

Table 5: Comparison of risk of malignancy of ACR-TIRADS categories with recent studies.

TIRADS category	Studies	Risk of malignancy (%)
1	Patil et al[23]	0
	De et al[24]	0
	Siddheshwar et al[25]	0
	Present study	0

Continued.

TIRADS category	Studies	Risk of malignancy (%)
2	Patil et al[23]	0
	De et al[24]	0
	Siddheshwar et al[25]	0
	Present study	0
3	Patil et al[23]	6.8
	De et al[24]	22.72
	Siddheshwar et al[25]	14.3
	Present study	9.6
4	Patil et al[23]	21.3
	De et al[24]	29.12
	Siddheshwar et al[25]	62.5
	Present study	33.3
5	Patil et al[23]	80
	De et al[24]	86.66
	Siddheshwar et al[25]	100
	Present study	80

Table 6: Statistical analysis of ACR-TIRADS by combining TIRADS 4 and 5 (moderately and highly suspicious lesion) as likely malignant and TIRADS 1, 2, and 3 as likely benign usg findings.

TIRADS category	FNAC						Chi-square	
	Malignant		Benign		Total			
	N	%	N	%	N	%	X^2	P value
TIRADS 4 and 5	6	66.666	5	13.157	11	23.40426	11.62	0.000652
TIRADS 1, 2 and 3	3	33.33	33	86.84	36	76.59574		
Total	9	100	38	100	47	100		
	Sensitivity		Specificity		PPV	NPV		
	66.66666667		86.84210526		54.54545	91.66667		

DISCUSSION

The study focuses on the diagnostic accuracy of the ACR-TIRADS 2017 in distinguishing between benign and malignant thyroid nodules. It begins by highlighting the rising incidence of thyroid cancer over the past three decades due to improved screening procedures. The importance of timely diagnosis to reduce mortality and morbidity is emphasized.

In this research, ultrasound characteristics based on ACR-TIRADS 2017 were evaluated for 50 patients who underwent neck ultrasound, followed by ultrasound-guided FNAC. Among the 50 nodules examined, 38 were benign, 9 were malignant, and 3 were undiagnostic. The majority of patients examined were female, with a higher prevalence of malignancy observed in females.

The analysis revealed that most nodules fell under the TIRADS 3 classification, with malignancy found in 19.1% of the nodules. Papillary carcinoma was the most common thyroid cancer type encountered. A significant proportion of benign nodules comprised colloid nodules.

The study found ACR-TIRADS categories 4 and 5 to be positively associated with malignancy, while categories 1, 2, and 3 were indicative of benign nodules. The sensitivity, specificity, positive predictive value, and negative predictive value of ACR-TIRADS in predicting malignancy were determined, with an overall accuracy of 82.9%.

Additionally, ultrasound findings such as nodule composition, echogenicity, shape, margins, and echogenic foci were examined for their predictive value. For instance, solid composition and hypoechoic echotexture were associated with a higher risk of malignancy, while taller-than-wide shape and microcalcifications showed specificity for malignancy prediction.

Comparative analysis with studies conducted by Patil et al, De et al and Siddheshwar et al revealed consistency in the risk stratification of thyroid nodules based on ACR-TIRADS categories.[23-25] These studies demonstrated varying degrees of sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for malignancy prediction using ACR-TIRADS, providing a comprehensive understanding of its diagnostic utility across different populations.

Furthermore, the study's findings regarding ultrasound characteristics such as nodule composition, echogenicity, shape, margins, and echogenic foci were compared with research conducted by Sankhla et al, Patil et al and De et al and others.[23,24,26] Consistency in the association of specific ultrasound features with malignancy risk was observed across these studies, reinforcing the predictive value of these parameters in thyroid nodule evaluation.

Moreover, the study's limitations regarding false-negative and false-positive results in FNAC were compared with findings from studies by Bloch, Handa et al, and Mundasad et al.[27-29] Despite variations in FNAC accuracy reported in these studies, the overall assessment highlighted the importance of considering both FNAC and ultrasound findings for comprehensive thyroid nodule evaluation.

The study underscores the significance of ultrasound-based ACR-TIRADS in differentiating between benign and malignant thyroid nodules, offering insights into risk stratification and guiding clinical decision-making. However, it acknowledges limitations in FNAC accuracy, emphasizing the need for further research in this area.

CONCLUSION

The purpose of this study was to classify thyroid nodules into various ACR-TIRADS 2017 categories and to analyse the suspicious sonographic features with FNAC reports in order to determine the risk of malignancy for each suspicious sonographic feature and for each ACR-TIRADS category. The study was conducted to evaluate diagnostic accuracy of USG based on ACR-TIRADS differentiating benign and malignant nodules and in comparing the findings with results of FNAC. Our study showed that the ACR-TIRADS 2017 is fairly sensitive, specific, and accurate tool for detecting thyroid cancer. It was observed that the ACR-TIRAD 2017 is a good predictor of malignancy with only one false positive case in the TR-5 category. Individual characteristics like Hypo-echogenicity ($p=0.000056$), lobulated or irregular margin ($p=0.00299$), taller than wide shape ($p=0.000254$), punctate echogenic foci/microcalcification ($p=0.0029$), and extra-thyroidal extension ($p=0.03$) were all significantly predictive of malignancy on USG. In conclusion, high resolution USG based on ACR-TIRADS is an accurate tool for evaluating thyroid nodule morphology. The following is accomplished by describing the findings using a standard lexicon and categorizing them using ACR-TIRADS 2017. Suspicious nodules can subsequently be subjected to FNAC correlation under USG direction to get a definitive diagnosis. The ACR-TIRADS 2017 increases uniformity in reporting, high accuracy in identifying malignant lesions, supports in clinical decision making, and the avoidance of unneeded FNACs, hence eliminating unnecessary patient suffering, cost, and resource waste.

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