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Original Research Article

Diagnostic value of thyroid imaging reporting and data system in thyroid nodules

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ABSTRACT

Background: The improved detection of TNs (TNs) with US has resulted in an increase in the number of thyroid fine needle aspiration biopsy (FNAB). Appropriate criteria are necessary to avoid an increase of rather unnecessary benign cytologic results in TNs. Thyroid imaging reporting and data system (TIRADS) was first used by Horvath et al in 2009. This was to standardize the reporting of results of thyroid (ultrasonography) US that can be understood by clinicians and also stratify the risk of malignancy of a lesion based on the US features of the lesion.
Methods: Cases with uninodular or multinodular goiter had been included. Evaluation of cases had been done using ultrasound of the neck. TNs were classified into categories according to thyroid imaging reporting and data system of the American colleague of radiologists (ACR-TIRADS).Cases were ordered for fine needle aspiration cytology (FNAC). Operable cases were only included in the study and postoperative histopathology was revised.
Results: The study included 46 patients. The different TIRADS categories were confronted with the results of cytology and histopathology. Combining TIRADS 2 and 3 as probably benign categories and TIRADS 4 and 5 as probably malignant categories, the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were respectively 100%, 84.38%, 73.68% and 100%. The accuracy of ACR-TIRADS was 89.13%.
Conclusions: ACR-TIRADS helps in stratifying nodular thyroid disease based on the risk of malignancy. It could lead to a significant decrease of the number of unnecessary FNABs.

Keywords: Thyroid, ACR, TIRADS

INTRODUCTION

US is widely used in the assessment of the thyroid gland. Among the different pathologies that can be depicted and characterized by US are nodules. Nodules can be benign or malignant. Some studies have shown that less than 10% of TNs are malignant and that thyroid US depicts nodules in up to 50% to 67% of the population.[1]

The improved detection of TNs with US has resulted in an increase in the number of thyroid FNAB and thus, an increase in the number of thyroid cancers diagnosed. Appropriate criteria are necessary to avoid an increase of rather unnecessary benign cytologic results in TNs. Although many guidelines and studies suggest that suspicious US features should be considered when selecting which TNs should be biopsied, we still need better guidelines for facilitating US reports in order to communicate with and reduce confusion among physicians and patients issues that are similar to the ones that brought about the creation of breast imaging reporting and data system (BI-RADS) categorizations.[2]

FNA is the most accurate and cost effective method for diagnostic evaluation of TNs. A review of

recently published data regarding thyroid cancer detection at US guided FNA indicates a sensitivity of 76-98%, specificity of 71-100%, false-negative rate of 0-5%, false positive rate of 0-5.7% and overall accuracy of 69-97% with the use of this method.[3]

The terminology thyroid imaging reporting and data system (TIRADS) was first used by Horvath et al in 2009, drawing inspiration from the BI-RADS of the ACR. This was in a bid to standardize the reporting of results of thyroid US that can be understood by clinicians and also stratify the risk of malignancy of a lesion based on the US features of the lesion.[4]

The ultrasound features in the ACR TI-RADS are categorized as benign, minimally suspicious, moderately suspicious or highly suspicious for malignancy. Points are given for all the ultrasound features in a nodule, with more suspicious features being awarded additional points.[5]

Tessler et al proposed ACR TI-RADS score that refers to five risk features: microcalcification, irregular shape, taller-than-wide, solidity and hypoechogenicity (Figure 1).[6] The risk of malignancy rises with the increase in the number of suspicious US features.

When assessing a nodule, the reader selects one feature from each of the first four categories and all the features that apply from the final category and sums the points. The point total determines the nodule's ACR TI-RADS level, which ranges from TR1 (benign) to TR5 (high suspicion of malignancy).[6]

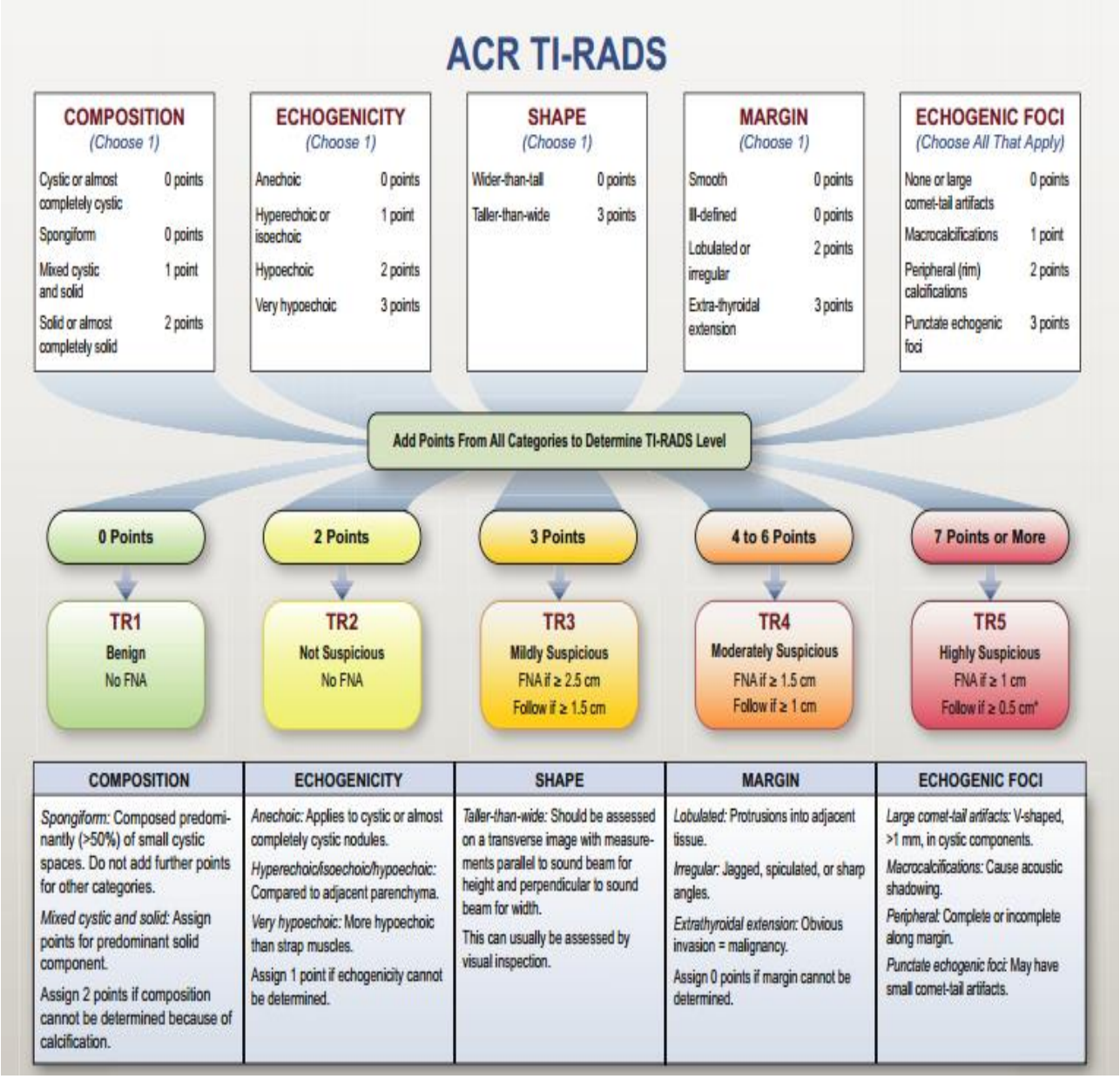

Figure 1: Chart showing five categories on the basis of the ACR TI-RADS TR levels and criteria for FNA or follow up ultrasound.

To make the system easy to understand and apply, the ACR TI-RADS does not include subcategories nor does it include a TR0 category to indicate a normal thyroid gland. In the ACR TI-RADS, recommendations for FNA or ultrasound follow-up are based on a nodule's ACR TIRADS level and its maximum diameter. For risk levels TR3 through TR5, the chart presents a size threshold at or above which FNA should be recommended.[6]

Biopsy of three or more nodules is poorly tolerated by patients and increases cost with little or no benefit and some added risk. Therefore, the committee recommends targeting no more than two nodules with the highest ACR TI-RADS point totals that meet criteria for FNA.[6]

Aim of the study

This study aimed to evaluate diagnostic accuracy of the US-based TI-RADS in risk stratification of malignancy in TNs and its valiability in avoiding unnecessary FNAC.

METHODS

Patients

During a period from January 2019 to December 2020, 46 patients were enrolled in the study referred to general surgery departments at Alzahraa university hospital in Cairo and Damanhur teaching hospital in Damanhur. Cases with uninodular or multinodular goiter either diagnosed clinically or radiologically were included. Evaluation of cases had been done using ultrasound of the neck. TNs were classified into categories according to thyroid imaging reporting and data system of the ACR. According to ACR-TIRADS, cases were classified into five categories: TIRADS 1, 2, 3, 4 and 5. Cases were ordered for FNAC and cytological results were expressed according to Bethesda classification. Operable cases were only included in the study either Bethesda 4 and 5 cases or operable cases due to compression manifestations. Postoperative histo-pathology had been revised.

Inclusion criteria

Patients with solitary or multiple TNs diagnosed by US, patients above 18 years and no sex predilection were included in the study.

Exclusion criteria

Patients with toxic goiter, bleeding tendency, patients with past history of thyroid surgery (subtotal or total with recurrent nodule), cases categorized as TIRADS 1 and cases with cytological results of Bethesda 1 were excluded from the study.

Ethical consideration

An informed consent was obtained from the patient concerning the complication of the procedure, the complication of the radioactive material, FNAC procedure and the acceptance to be enrolled in the study.

Methods

All patients in this study were subjected to thorough history taking including age, sex, family history of thyroid cancer, neck irradiation, rapid nodule growth, hoarseness of voice and the presence of hypo or hyperthyroidism symptoms as well as compression manifestations (dyspnea and dysphagia).

Laboratory investigations done were T3, T4, TSH, PT and PTT.

Ultrasound neck examined thyroid gland and classified nodules according to TIRADS score of the ACR TI-RADS and examining cervical lymph nodes.

US-guided FNAC

All patients were subjected to FNAC. Patients having more than one nodule, only the nodule having the higher TIRADS score was evaluated.

Surgical procedure

The forty six cases had undergone excision either total or hemi-thyroidectomy.

Pathological examination of FNAC smears and thyroidectomy specimens were done.

Correlation of the results of TIRADS classification with cytological and postoperative histopathological results had been done.

Statistical analysis

Data were coded and entered using the statistical package SPSS (statistical package for the social sciences) version 23.

RESULTS

The study included 46 patients. There were thirty nine, 39 females (84.8%) and seven, 7 males (15.2%). Their ages ranged from 24 to 70 years, mean age±standard deviation 42.98±12.32 years. All patients were evaluated by ultrasound and TNs were classified according to TIRADS score of the ACR-TIRADS. All cases had undergone FNAB from their nodules and results were expressed according to Bethesda score. Patients having more than one nodule, only the nodule having the higher TIRADS score was biopsied. Included cases had undergone excisional biopsy either total or hemi-thyroidectomy and postoperative histopathological examination had been done.

TIRADS categories, nodule size, cytology results and risk of malignancy

TIRADS categories (Table 1)

The ultrasound features of each thyroid nodule were characterized and classified into TIRADS categories according to TIRADS score of the ACR-TIRADS.

The most encountered category in our study was TIRADS 4; 18 cases (39.1%) followed by TIRADS 2; 16 cases (34.8%) then TIRADS 3; 11 cases (23.9%) and lastly TIRADS 5; 1 case (2.2%).

Nodule size (Table 2)

The mean size of TNs was calculated in each TIRADS category and estimated in centimeters as mean±standard deviation (SD).

The mean size of TNs in TIRADS 2 category is 2.9±0.95 cm. In TIRADS 3, the mean size is 1.8±0.64 cm. In TIRADS 4, the mean size is 1.9±1.05 cm. In TIRADS 5, the mean size is 0.8 cm. The mean nodule size of all categories is 1.9±0.93 cm.

Cytology results (Table 3)

All patients in the current study were subjected to FNAB and the results were classified according to Bethesda system.

In our study, Bethesda 2 was the most encountered category on FNAC accounting for 21 cases (45.7%). Bethesda III category accounting for 14 cases (30.4%), while Bethesda IV category accounting for 9 cases (19.6%), lastly Bethesda V category encountered in 2 cases (4.3%).

The cytology results of each TIRADS category were as follows:

In TIRADS 2 category (16 cases); 14 cases (87.5%) were found to be Bethesda II category where 2 cases (12.5%) were Bethesda III.

In TIRADS 3 category (11 cases); 5 cases (45.5%) were found to be Bethesda II category where 6 cases (54.5%) were Bethesda III.

In TIRADS 4 category (18 cases); 2 cases (11.1%) were found to be Bethesda II category, 6 cases (33.3%) were Bethesda III, 8 cases (44.4%) were Bethesda IV where 2 cases (11.1%) were Bethesda V.

The only case in TIRADS 5 category was Bethesda V (100%).

Histopathology results (Table 4)

In the current study, the included cases were all operable either because of being Bethesda category IV and V or due to compression manifestations and the histopathology results were as following:

TIRADS 2 cases were 16 cases; 14 cases were Bethesda II category andd 2 cases were Bethesda III category. Postoperative histopathology of these cases was found to be benign.

TIRADS 3 cases were 11 cases; 5 cases were Bethesda II category and 6 cases were Bethesda III category. Postoperative histopathology of these cases was found to be benign.

TIRADS 4 cases were 18 cases; 2 cases were Bethesda II category and they found to be benign. 6 cases were Bethesda III of which one case (16.7%) was found to be benign and 5 cases (83.3%) found to be malignant. 8 cases were Bethesda IV of which 2 cases (25%) found to be benign while 6 cases (75%) found to be malignant. 2 cases were Bethesda V which found to be malignant (100%). Total number of benign cases in TIRADS 4 category was 5 cases (27.8%) while the total number of malignant cases in this category was 13 cases (72.2%).

The only case in TIRADS 5 category which was Bethesda IV was malignant (100%).

TIRADS categories and risk of malignancy (Table 5)

The different TIRADS categories were confronted with the results of pathology and the risk of malignancy was calculated for each TIRADS category and the results were as following; the total number of malignant cases in the current study is 14 cases (30.4%). 13 cases were TIRADS 4 category and one case was TIRADS 5. In TIRADS 2 and 3 categories, there were no malignant cases. In TIRADS 4 category, there are 13 malignant cases of 18 cases in this category with 72.2% risk of malignancy. While the only case in TIRADS 5 category was malignant with 100% risk of malignancy.

Table 1: TIRADS categories.

TIRADS	No. of cases (46 cases)	Percentage (%)
TR 2	16	34.8
TR 3	11	23.9
TR 4	18	39.1
TR 5	1	2.2

Table 2: Nodule size.

TIRADS	No. of cases	Nodule size, cm (mean±SD)
TR2	16	2.9±0.95
TR3	11	1.8±0.64
TR4	18	1.9±1.05
TR5	1	0.8
Total	46	1.9±0.93

Table 3: Cytology results.

TIRADS	Bethesda				
	No. of cases	II (%)	III (%)	IV (%)	V (%)
TR 2	16	14 (87.5)	2 (12.5)		
TR 3	11	5 (45.5)	6 (54.5)		
TR 4	18	2 (11.1)	6 (33.3)	8 (44.4)	2 (11.1)
TR 5	1			1 (100)	
Total	46	21 (45.7)	14 (30.4)	9 (19.6)	2 (4.3)

Table 4: Histopathology results.

TIRADS	No. of cases	Postoperative pathology	
		Benign (%)	Malignant (%)
TR 2	16	16 (100)	-
Bethesda II	14	14 (100)	-
Bethesda III	2	2 (100)	-
Bethesda IV	-	-	
Bethesda V	-	-	
TR 3	11	11 (100)	-
Bethesda II	5	5 (100)	- -
Bethesda III	6	6 (100)	-
Bethesda IV	-	-	
Bethesda V	-	-	
TR 4	18	5 (27.8)	13 (72.2)
Bethesda II	2	2 (100)	-
Bethesda III	6	1 (16.7)	5 (83.3)
Bethesda IV	8	2 (25)	6 (75)
Bethesda V	2	-	2 (100)
TR 5	1		1 (100)
Bethesda II			
Bethesda III			
Bethesda IV	1		1 (100)
Bethesda V			
Total	46	32 (69.6)	14 (30.4)

Table 5: TIRADS categories and risk of malignancy.

TIRADS	n=46	Histopathology		Risk of malignancy (%)
		Benign (n=32)	Malignant (n=14)	
TR 2	16	16	-	0.0
TR 3	11	11	-	0.0
TR 4	18	5	13	72.22
TR 5	1	-	1	100.0

Table 6: Agreement (sensitivity, specificity and accuracy) for TIRADS.

TIRADS	Histopathology				Sensitivity	Specificity	PPV	NPV	Accuracy
	Benign (n=32)		Malignant (n=14)						
	No.	%	No.	%					
TR2+TR3	27	84.4	0	0.0	100.0	84.38	73.68	100.0	89.13
TR4+TR5	5	15.6	14	100.0					

PPV: positive predictive value; NPV: negative predictive value.

Agreement (sensitivity, specificity and accuracy) for TIRADS (Table 6)

Combining TIRADS 2 and 3 as probably benign categories and TIRADS 4 and 5 as probably malignant categories, the sensitivity, specificity, PPV and NPV were respectively 100%, 84.38%, 73.68% and 100%. The accuracy of ACR TIRADS was 89.13%.

DISCUSSION

TNs are common. The prevalence of TNs in autopsies ranges between 8.2 and 64.6%, while detection by ultrasound has increased from 19% to 68% with the technological development of ultrasound equipment.[7]

The value of US in discriminating benign from malignant TNs has been proved in many of previous studies.[8] Many scoring systems have been evaluated to identify the risk of malignancy in the TNs.[9] However, many of these systems are complex, time consuming and are not easily applied. ACR TI-RADS score proposed recently is a simple and practical system in evaluating thyroid nodules.[6]

The aim of the present study was to assess ACR TI-RADS as a reliable, noninvasive and simple score in evaluation of TNs and make risk stratification of thyroid nodules according to this score.

Women were more prone to thyroid problems than men.[10] The current study included 46 patients. There were thirty nine, 39 females (84.8%) and seven, 7 males (15.2%).

In the current study, we included TIRADS categories 2 to 5 excluding TIRADS 1 category from the study, as this category represented TNs without any suspicious criteria at all. Also we excluded cases with Bethesda I category which represents inconclusive cytology results.

In our study, the overall mean nodule size (±SD) of the studied TNs was 1.9±0.93 cm. According to Modi et al 2020, the mean nodule size in their study was 2.4±1.31 cm.[11]

In the current study, the mean nodule size in TIRADS 2 category is 2.9±0.95 cm. According to Modi et al 2020, the mean nodule size for the same category was 2.8±0.95 cm.[11] In TIRADS 3 category of our study the mean nodule size was 1.8±0.64 cm. According to Modi et al 2020, the mean nodule size in TIRADS 3 category was 2.9±1.27 cm.[11]

The mean nodule size in TIRADS 4 category of our study was 1.9±1.05 cm. According to Modi et al 2020, the mean nodule size for the same category was 2.3±1.29.[11] In TIRADS 5 category of our study the mean nodule size was 0.8 cm. According to Modi et al 2020, the mean nodule size in TIRADS 5 category was 1.7±1.11cm.[11]

The nodule size had an important issue in managing TNs. In 2017, Tessler et al evoked the cutoff size for thyroid nodules in TIRADS categories 3 to 5 at which FNAB should be done.[6]

All included cases in the current study which have TIRADS classification from 2 to 5 had been subjected to FNAB. The results were expressed according to Bethesda score.

In our study, TIRADS 2 category cases were 16 cases with the following cytological results; 14 cases (87.5%) were found to be Bethesda II category where 2 cases (12.5%) were Bethesda III. According to Modi et al 2020, cytological results of TIRADS 2 category were as following: 12.5% of cases were Bethesda I, 62.5% were Bethesda II and 25% were Bethesda III.[11] In both studies, most frequent cytological result in TIRADS 2 category was Bethesda II then Bethesda III. None of TIRADS 2 category cases had cytological result of Bethesda categories more than Bethesda III.

In the current study, TIRADS 3 category were 11 cases with the following cytological results; 5 cases (45.5%) were found to be Bethesda II category while 6 cases (54.5%) were Bethesda III category. According to Modi et al 2020, 96.3% of TIRADS 3 cases was Bethesda II, 2.8% of cases was Bethesda III and 0.9% was Bethesda IV.[11] In both studies, most of TIRADS 3 category cases had cytological results of Bethesda II and III.

The cytological results of TIRADS 2 and 3 categories in our study and in Modi et al were mainly Bethesda II and III reflecting that classifying a thyroid nodule as TIRADS 2 or 3 categories is a predictor of being a benign nodule.[11]

In the current study, TIRADS 4 category cases were 18 cases with the following cytological results; 2 cases (11.1%) were Bethesda II, 6 cases (33.3%) were Bethesda III, 8 cases (44.4%) were Bethesda IV and 2 cases (11.1%) were Bethesda V. According to Singaporewalla et al cytological results of TIRADS 4 category cases were as following; 33.3% of cases were Bethesda II, 33.3% of cases were Bethesda III and 33.3% of cases were Bethesda IV.[12]

According to our study and Singaporewalla et al cytological results of TIRADS 4 category cases have a considerable percentage of Bethesda IV which denoted suspicion for follicular lesion or follicular lesion which have 15-30% risk of malignancy.[12]

In the current study, we had one case in TIRADS 5 category which was Bethesda IV. According to Singaporewalla et al cytological results of TIRADS 5 category showed that 60 % of cases were Bethesda V and VI.[12]

According to our study and Singaporewalla et al cytological results of TIRADS 5 category cases had a considerable percentage of Bethesda IV, V, VI with 15-30%, 60-75%, 97-99% risk of malignancy respectively.[12]

In the current study, we included the operable cases to ensure diagnostic reliability of ACR-TIRADS score. Operated cases were either cytology proven malignancy or suspicious for malignancy (Bethesda IV and V in our study) or operated due to compression manifestations due to goitre.

In our study, TIRADS 2 and 3 cases (27 cases) were found to be benign on postoperative histopathology with 0.0% risk of malignancy. According to Dy et al TIRADS 3 category has been found to have 12.5% risk of malignancy.[13]

In TIRADS 4 category in our study, there are 13 malignant cases of 18 cases in this category with 72.2% risk of malignancy. According to Dy et al TIRADS 4 category has been found to have 33.3% risk of malignancy.[13]

In TIRADS 5 category in our study, only one case in this category which has been found to be malignant with 100% risk of malignancy. According to Dy et al TIRADS 5 category has been found to have 66.67% risk of malignancy.[13]

In the current study, combining TIRADS 2 and 3 as probably benign categories and TIRADS 4 and 5 as probably malignant categories, the sensitivity, specificity, PPV and NPV were respectively 100%, 84.38%, 73.68% and 100%. The accuracy of ACR-TIRADS was 89.13%. According to Nasser et al the sensitivity and specificity of TIRADS on considering TR4 and TR5 lesions positive (suspiciuos) when compared with histopathological findings were 100% and 79.2% respectively with PPV of 54.5%, NPV of 100% and accuracy of 83.3%.[14]

Study limitations

A limitation of this study was that it was of relative small sample size. It would be beneficial to conduct another study on larger number of patients.

CONCLUSION

TIRADS helps in stratifying nodular thyroid disease based on the risk of malignancy. ACR TI-RADS classification is reliable in predicting thyroid malignancy. It could lead to a significant decrease of the number of unnecessary FNABs. Further studies are recommended for more validation of a classification system that will be simple to use, reliable, reproducible and facilitate better management of nodular thyroid disease.

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