ORIGINAL ARTICLE

Diagnostic Accuracy of Thyroid Cancer Using the American Thyroid Association Guidelines and American College of Radiology-Thyroid Imaging Reporting and Data System

Wasu Tanasoontrarat, MD[1], Suwara Issaragrisil, MD[1]

[1] Department of Radiology, Faculty of Medicine Vajira Hospital, Navamindradhiraj University, Bangkok, Thailand

Objective: To compare the American Thyroid Association (ATA) classification system of 2015 with the American College of Radiology (ACR) Thyroid Imaging Reporting and Data System (TI-RADS) of 2017 to determine the superior system to predict cancer risk in thyroid nodules.

Materials and Methods: The present study was a retrospective study that included patients with thyroid nodule(s) referred to the department of radiology for fine-needle aspiration (FNA) between February 2019 and March 2021. The authors assessed the ability of either system to predict malignancy based on FNA cytology results. Sensitivity, specificity, negative predictive values (NPV), and positive predictive values (PPV) were calculated.

Results: One hundred sixty-five nodules were reviewed based on the ATA guideline of 2015 and ACR-TI-RADS of 2017. The sensitivity, specificity, PPV, and NPV of the ATA guidelines were 95.45%, 65.04%, 29.58%, and 98.94%, respectively, while that of the ACR-TI-RADS were 95.45%, 62.24%, 28%, and 98.89%, respectively.

Conclusion: The ATA guidelines of 2015 and the ACR-TI-RADS of 2017 have comparable sensitivity and NPV for thyroid carcinoma diagnosis with moderate specificity for both systems. These results confirm a high probability of both systems rejecting malignancy.

Keywords: Thyroid; FNA; ATA guideline; ACR-TI-RADs

Received 6 February 2023 | Revised 5 June 2023 | Accepted 7 June 2023

J Med Assoc Thai 2023;106(7):722-7

Website: http://www.jmatonline.com

Thyroid nodules are a common finding in the general population, and their detection is important. Thyroid ultrasound (US) is a widely used imaging modality to evaluate the risk of malignancy.

Medical societies worldwide have published guidelines defining the clinical and ultrasonography findings that necessitate fine-needle aspiration (FNA). However, a routine, adequate, and uniform standardizing system for thyroid nodule ultrasonography classification is required.

The Thyroid Imaging Reporting and Data System (TI-RADS) of 2017 and the American Thyroid Association guideline (ATA) of 2015 are two of the most well-known thyroid nodule classifications in the United States[1].

Horvath et al.[2] introduced the TI-RADS for an ultrasonographic screening of patients with thyroid nodules to decide on FNA indication since TI-RADS criteria have proposed several classifications over the years, including Kwak's TI-RADS[3] and K-TI-RADs in 2016[4].

In 2017, the American College of Radiology (ACR) recommended a point system for the assessment of imaging thyroid nodules called ACR-TI-RADS. The ACR-TI-RADS classification of the nodule is determined by the total of points allocated to five ultrasonography characteristics[5]. The ATA 2015 guideline stratifies thyroid nodules into five risk categories based on US features and estimated risk of malignancy, including high suspicious (with an estimated 70% to 90% risk of malignancy), intermediate suspicious (10% to 20%), low suspicious (5% to 10%), very low suspicious (less than 3%), and benign.

The present study aimed to compare the ATA 2015 classification system with the ACR-TI-RADS

Correspondence to:

Tanasoontrarat W.

Department of Radiology, Faculty of Medicine Vajira Hospital, Navamindradhiraj University, Bangkok 10300, Thailand.

Phone & **Fax**: +66-86-5656293

Email: wasutanas@gmail.com

How to cite this article:

Tanasoontrarat W, Issaragrisil S. Diagnostic Accuracy of Thyroid Cancer Using the American Thyroid Association Guidelines and American College of Radiology-Thyroid Imaging Reporting and Data System. J Med Assoc Thai 2023;106:722-7.

DOI: 10.35755/jmedassocthai.2023.07.13780

2017 to determine the superiority of the other in predicting cancer risk in thyroid nodules.

Materials and Methods

The present study was retrospectively conducted at the Department of Radiology, Faculty of Medicine Vajira Hospital, Navamindradhiraj University. The study was approved by the Institutional Medical Ethics Committee Board (025/64).

Patient selection

Patients with thyroid nodule(s) were referred to the Department of Radiology for FNA between February 2019 and March 2021. Patients with a history of thyroid surgery and those with a known history of thyroid cancer were excluded. After the exclusion criteria, 208 patients with 212 thyroid nodules were included.

Sonographic examination and cytological examination

The US equipment included the Logiq E9 and Logiq E10 (GE Healthcare, United States) with a 5 to 12-MHz linear probe. The US features were assessed for each nodule characteristic, including size, composition (cystic, spongiform, cystic/solid, and almost completely solid or solid), echogenicity (anechoic, iso/hyperechoic, hypoechoic, and very hypoechoic), margins (smooth, ill-defined, lobulated/irregular, and extrathyroidal extension), presence of echogenic foci (comet-tail artifacts, macrocalcification, rim calcification, and punctate foci), and nodule shape (wider than tall or taller than wide).

FNA was performed by two interventional radiologists, freehand technique under US guidance, using a 23- or 25-gauge needle. On average, one or two passes were performed for each nodule. Aspirated material was expelled on glass slides and immediately placed in 95% ethanol for Papanicolau staining.

Smears were interpreted using the Bethesda System for Cytological Classification of Thyroid Nodules[6] as follows, 1) non-diagnostic or unsatisfactory, 2) benign, 3) atypia of undetermined significance, 4) a follicular neoplasm or suspicious for a follicular neoplasm, 5) suspicious for malignancy, and 6) malignant.

Only 165 nodules with Bethesda categories 2 and 6 were included in the present study since these categories have a very low probability of error[7].

The Bethesda system was used to divide benign and malignant nodules based on the cytological results as Bethesda 2 for benign and Bethesda 6 for malignant nodules. The ATA class very low and low suspicions were low-risk types and intermediate to highly suspicion were high-risk types for ultrasonographic criteria. Pure cystic nodules were recognized as a benign pattern in the ATA guidelines, but they were not included in this analysis since aspiration in these thyroid lesions has a very low malignancy risk (less than 1%)[1]. ACR-TI-RADS scores of 1, 2, and 3 were considered low-risk type and TI-RAD scores 4 and 5 as high-risk type of nodules. All US examinations were reviewed by two 5-year experienced radiologists, blinded to the cytological result. Both reviewed the images and scored the nodule grade based on the ATA and ACR-TI-RADS.

Statistical analysis

Characteristics data were presented as mean ± standard deviation (SD) and n (%). The differences in mean of continuous data between benign and malignant groups were analyzed using independent t-test. The chi-square test was used to compare the differences of categorical data and diagnostic values. Sensitivity, specificity, negative predictive values (NPV), and positive predictive values (PPV) were calculated for the ATA guideline and ACR-TI-RADS between the benign and malignant groups. In the context of the present study, sensitivity was the probability that the high-risk US category would include a malignant thyroid nodule. Likewise, specificity was the likelihood that a low-risk US category would exclude a malignant nodule. A PPV was the percentage of high-risk nodules in a given US category with a malignant cytology diagnosis. Conversely, an NPV was a percentage of low-risk nodules in a given US category without a malignant cytology diagnosis. A p-value of less than 0.05 was used to determine statistical significance. All statistical data analyses were performed using IBM SPSS Statistics, version 24.0 (IBM Corp., Armonk, NY, USA).

Results

Two hundred twenty-two thyroid nodules with the complete cytological study were submitted (Bethesda categories 2-6). Only Bethesda categories 2 (benign nodule) and 6 (malignant nodule) were included in the present study. There were 175 nodules included. The 175 nodules were retrospectively reviewed based on the ATA 2015 guidelines and

Table 1. Malignancy rates of thyroid nodules in each ATA 2015 and ACR-TI-RADS

Classification	No. of case			Malignancy rate (%)	Expected malignancy rate[a] (%)
	Total (n=165)	Benign (n=143)	Malignant (n=22)		
ATA 2015					
Benign	0	0	0	0.0	<1
Very low suspicion	20	20	0	0.0	<3
Low suspicion	74	73	1	1.4	5-10
Intermediate suspicion	19	16	3	15.8	10 to 20
High suspicion	52	34	18	34.6	>70 to 90
ACR-TI-RADS					
1	7	7	0	0.0	0
2	23	23	0	0.0	<2
3	60	59	1	1.7	≤5
4	31	27	4	12.9	5.1 to 20
5	44	27	17	38.6	>20

ATA=American Thyroid Association Guidelines; ACR-TI-RADS=American College of Radiology Thyroid Imaging and Reporting Data System

[a] Expected malignancy rates as previously reported[8,9]

Table 2. Malignant rates of thyroid nodules in ATA 2015 low-risk type and ATA 2015 high-risk type

	Cytological diagnosis n (%)		p-value
	Benign (n=143)	Malignant (n=22)	
ATA 2015			<0.001
ATA low-risk (category benign, very low suspicion, low suspicion)	93 (65.04)	1 (4.55)	
ATA high-risk (category intermediate suspicion, high suspicion)	50 (34.96)	21 (95.45)	

ATA=American Thyroid Association Guidelines

Table 3. Malignant rates of thyroid nodules in ACR-TI-RADS low-risk type and ACR-TI-RADS high-risk type

	Cytological diagnosis n (%)		p-value
	Benign (n=143)	Malignant (n=22)	
ACR-TI-RADS			<0.001
ACR-TI-RADs low-risk (score 1, 2, 3)	89 (62.24)	1 (4.55)	
ACR-TI-RADs high-risk (score 4, 5)	54 (37.76)	21 (95.45)	

ACR-TI-RADS=American College of Radiology Thyroid Imaging and Reporting Data System

ACR-TI-RADS 2017. Ten nodules that could not be classified based on the ATA guidelines were not included in the analysis. Therefore, 165 nodules were included in the present study analysis.

Of the 165 nodules, 143 were benign and 22 were malignant. There were no significant differences in age at 53.5± 14.2 years versus 50.8±13.4 years (p=0.332) or gender distribution at 89.1% female versus 89.5% female (p=0.659) between patients with benign and malignant nodules. The mean size of nodules was 1.94±1.06 cm. The size of benign nodules was significantly larger than malignant nodules at 2.03±1.08 cm versus 1.35±0.65 cm (p<0.001).

The number and percentage of benign and malignant nodules in each ATA guidelines and ACR-TI-RADS category are shown in Table 1. After dividing the low-risk and high-risk nodules based on US criteria, 94 nodules were ATA low-risk type, 71 were ATA high-risk type, 90 were ACR-TI-RADS low-risk, and 75 were ACR-TI-RADS high-risk type (Table 2, 3). The sensitivity, specificity, PPV, and NPV of the ATA guideline were 95.45%, 65.04%, 29.58%, and 98.94%, and that of the ACR-TI-RADS were 95.45%, 62.24%, 28%, and 98.89%, as shown in Table 4.

Ten nodules (5.71%) could not be classified by the ATA guideline. Of these, two were Bethesda category 6. Both of them were hyperechoic nodules with microcalcification.

Table 4. Sensitivity and specificity of ATA 2015 and ACR-TI-RADS

Classification	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)
ATA 2015	95.45% (77.16 to 99.88)	65.04% (56.62 to 72.81)	29.58% (19.33 to 41.59)	98.94% (94.21 to 99.97)
ACR-TI-RADS	95.45% (77.16 to 99.88)	62.24% (53.75 to 70.20)	28.00% (18.24 to 39.56)	98.89% (93.96 to 99.97)

ATA=American Thyroid Association Guidelines; ACR-TI-RADS=American College of Radiology Thyroid Imaging and Reporting Data System; CI=confidence interval

Discussion

There is widespread acceptance of thyroid US as an imaging modality for screening thyroid carcinoma. Guidelines have recently been developed to allow US imaging for the identification and stratification of nodules based on the risk of malignancy. Among the classification systems that have been described, the ATA guideline and the ACR-TI-RADS are simple and can be easily adopted.

The main difference between these two guidelines is that the ATA guideline is pattern-based whereas ACR-TI-RADs are score-based.

In the present study, only Bethesda categories 2 and 6 (n=165) were used to compare TI-RADS and ATA scores with cytological results, as the probability of error for these two categories is less than 3%[7].

The present study showed that malignant nodules have smaller sizes compared to benign nodules, mainly because the nodules sent to our department for FNA were based on guideline recommendations, which had smaller cutoff size criteria for FNA in the more worrisome ATA guideline nodules (1 cm or more for intermediate to high-suspicion nodules in ATA guideline versus 1.5 cm or more for low suspicions nodule and 2 cm or more for very low suspicion nodules) and higher ACR-TI-RADs score nodules (1.5 cm or more for TI-RADs 4 and 1 cm or more for TI-RADs 5 versus 2.5 cm or more for TI-RADs 3 and no FNA is required in TI-RADs 1 and 2). However, several previous works of the literature showed that the size of benign and malignant nodules do not significantly differ[8-10].

The authors discovered a lower rate of malignancy in the ATA high-suspicion group at 34.6% than the expected malignancy rates reported by the organizations in their guidelines at 70% to 90%[11]. The lower PPV might be explained in part by the low number of malignant nodules in the present study. However, other ATA categories and ACR-TI-RADS scores of 1 to 5 show comparable results to the reports in their guidelines. There are previous studies that also found a lower malignancy rate within the ATA high-suspicion pattern compared with the expected rate in the guideline[12-14].

The present study demonstrated a similar diagnostic accuracy between the ATA guideline and the ACR-TI-RADs with very high sensibility and NPV for screening thyroid cancer of 95.45% and 98.94% versus 95.45% and 98.89% with moderate specificity for both systems at 65.04% and 62.24% for ATA and the ACR-TI-RADS, respectively. These results are compatible with those reported in previous studies[4,13,15], which confirm a high probability of both systems in rejecting malignancy. In addition, our study revealed the presence of a nodule that exhibited a false negative result according to both the ATA guideline and the ACR-TIRADS (specifically, ATA low suspicion and ACR-TIRADS score 3). This nodule had a size of approximately 1.1 cm and displayed the characteristic features of a well-defined hyperechoic solid nodule.

Recent studies made a direct comparison between the ACR-TI-RADS and ATA guidelines. Unlike the present study, Ha et al.[16], had studied 1,802 patients with final diagnoses and found that ATA guidelines exhibited higher sensitivity but lower specificity than the ACR-TI-RADS with sensitivity of 89.6% versus 74.7% and specificity of 33.2% versus 67.3%, respectively. Gal et al.[17] also reported a large cohort of 1,758 patients that underwent thyroidectomy and showed that ATA guidelines demonstrated higher sensitivity and lower specificity than ACR-TI-RADS with sensitivity of 95.5% versus 81.6% and specificity of 73% versus 79.7%. This difference between their study and our study may be partly due to our small population. Moreover, our study regarded the nodules as benign lesions based on cytology.

However, the present study revealed that 10 of 175 nodules (5.71%) could not be classified based on the ATA guideline and were excluded. The sonographic pattern in this unclassified group was hyperechoic nodule with microcalcification. The present study showed that the risk of malignancy in this group is high at 20%. Yoon et al.[13] have reported in their series of 1,293 nodules that 3.4% of patients are ATA unclassified nodules, and of these 18.2% were malignant. Additionally, they showed that the nodules

were the iso- to hyperechoic nodules combined with suspicious features, including microlobulated or irregular margin, microcalcifications, or mixed calcification. This means that the iso- or hyperechoic nodules, which were known as benign features, showing suspicious pattern can carry a relatively high risk of malignancy. The interpretation in this particular group requires more attention and should be included in the ATA classification in the future.

The present study has limitations. Firstly, it has a smaller number of thyroid nodules compared to other studies. Furthermore, all analyses were based on recorded static images and may have led to misdiagnosis by the ATA guidelines and ACR-TI-RADS. Additionally, an interobserver analysis had not been performed. Furthermore, the nodules in the present study were divided into benign and malignant nodules based on cytological results, and the authors did not compare the risk categories with final pathological results after thyroidectomy because the authors were not able to follow up with sufficient patients. The final histopathological results remained necessary, although, only Bethesda categories 2 and 6 were included. Additionally, the present study represented the effort of a single center to use ATA/ACR-TI-RADS diagnostic guidelines in clinical practice, however, results must be confirmed by other centers.

Conclusion

In conclusion, the ultrasonographic patterns proposed by the ATA 2015 guidelines and the ACR-TI-RADS 2017 have comparable sensitivity and NPV for diagnosing thyroid carcinoma with moderate specificity for both systems. These results confirm a high probability of both systems to reject malignancy.

What is already known on this topic?

Recent studies made a direct comparison between the ACR-TI-RADS and ATA guidelines and the results were varied.

What does this study add?

This study supports a high probability of both systems to reject malignancy of thyroid nodule by using ultrasonographic pattern.

Ethical approval

The present study was retrospectively conducted at the Department of Radiology, Faculty of Medicine Vajira Hospital, Navamindradhiraj University. The study was approved by the Institutional Medical Ethics Committee Board (025/64).

Authors' contributions

Conceptualization, Data acquisition, Data curation: WT and SI. Writing and original draft preparation: WT.

Conflicts of interest

The authors declare that they have no conflict of interest.

References

1. Haugen BR, Alexander EK, Bible KC, Doherty GM, Mandel SJ, Nikiforov YE, et al. 2015 American Thyroid Association management guidelines for adult patients with thyroid nodules and differentiated thyroid cancer: The American Thyroid Association guidelines task force on thyroid nodules and differentiated thyroid cancer. Thyroid 2016;26:1-133.
2. Horvath E, Majlis S, Rossi R, Franco C, Niedmann JP, Castro A, et al. An ultrasonogram reporting system for thyroid nodules stratifying cancer risk for clinical management. J Clin Endocrinol Metab 2009;94:1748-51.
3. Kwak JY, Han KH, Yoon JH, Moon HJ, Son EJ, Park SH, et al. Thyroid imaging reporting and data system for US features of nodules: a step in establishing better stratification of cancer risk. Radiology 2011;260:892-9.
4. Zhang J, Liu BJ, Xu HX, Xu JM, Zhang YF, Liu C, et al. Prospective validation of an ultrasound-based thyroid imaging reporting and data system (TI-RADS) on 3980 thyroid nodules. Int J Clin Exp Med 2015;8:5911-7.
5. Tessler FN, Middleton WD, Grant EG, Hoang JK, Berland LL, Teefey SA, et al. ACR Thyroid Imaging, Reporting and Data System (TI-RADS): White paper of the ACR TI-RADS Committee. J Am Coll Radiol 2017;14:587-95.
6. Cibas ES, Ali SZ. The Bethesda system for reporting thyroid cytopathology. Am J Clin Pathol 2009;132:658-65.
7. Alshaikh S, Harb Z, Aljufairi E, Almahari SA. Classification of thyroid fine-needle aspiration cytology into Bethesda categories: An institutional experience and review of the literature. Cytojournal 2018;15:4.
8. Koc AM, Adıbelli ZH, Erkul Z, Sahin Y, Dilek I. Comparison of diagnostic accuracy of ACR-TIRADS, American Thyroid Association (ATA), and EU-TIRADS guidelines in detecting thyroid malignancy. Eur J Radiol 2020;133:109390.
9. Rios A, Torregrosa B, Rodríguez JM, Rodríguez D, Cepero A, Abellán MD, et al. Ultrasonographic risk factors of malignancy in thyroid nodules. Langenbecks Arch Surg 2016;401:839-49.

10. Tae HJ, Lim DJ, Baek KH, Park WC, Lee YS, Choi JE, et al. Diagnostic value of ultrasonography to distinguish between benign and malignant lesions in the management of thyroid nodules. Thyroid 2007;17:461-6.
11. Zheng Y, Xu S, Kang H, Zhan W. A single-center retrospective validation study of the American College of Radiology Thyroid Imaging Reporting and Data System. Ultrasound Q 2018;34:77-83.
12. Lauria Pantano A, Maddaloni E, Briganti SI, Beretta Anguissola G, Perrella E, Taffon C, et al. Differences between ATA, AACE/ACE/AME and ACR TI-RADS ultrasound classifications performance in identifying cytological high-risk thyroid nodules. Eur J Endocrinol 2018;178:595-603.
13. Yoon JH, Lee HS, Kim EK, Moon HJ, Kwak JY. Malignancy risk stratification of thyroid nodules: Comparison between the Thyroid Imaging Reporting and Data System and the 2014 American Thyroid Association management guidelines. Radiology 2016;278:917-24.
14. Persichetti A, Di Stasio E, Guglielmi R, Bizzarri G, Taccogna S, Misischi I, et al. Predictive value of malignancy of Thyroid Nodule Ultrasound Classification Systems: A prospective study. J Clin Endocrinol Metab 2018;103:1359-68.
15. Russ G, Royer B, Bigorgne C, Rouxel A, Bienvenu-Perrard M, Leenhardt L. Prospective evaluation of thyroid imaging reporting and data system on 4550 nodules with and without elastography. Eur J Endocrinol 2013;168:649-55.
16. Ha EJ, Na DG, Baek JH, Sung JY, Kim JH, Kang SY. US fine-needle aspiration biopsy for thyroid malignancy: Diagnostic performance of seven society guidelines applied to 2000 thyroid nodules. Radiology 2018;287:893-900.
17. Gao L, Xi X, Jiang Y, Yang X, Wang Y, Zhu S, et al. Comparison among TIRADS (ACR TI-RADS and KWAK- TI-RADS) and 2015 ATA Guidelines in the diagnostic efficiency of thyroid nodules. Endocrine 2019;64:90-6.