The Egyptian Journal of Hospital Medicine (July 2024) Vol. 96, Page 3019-3024

The Concordance between the Thyroid Imaging Reporting and Data System and Thy Cytological Classification

Shrief Ramadan Abd Elkhalek Abd Elrahman[1], Asmaa Gaber Abdou[2], Asmaa Yahia Sharfeldin[3], Ahmed Yehia Aboelenin[4], Ola Taher Ismail Allam*[1]

Departments of [1]Radiodiagnosis, Interventional Radiology and Medical Imaging, [2]Pathology, [3]Public Health and Community Medicine, Faculty of Medicine, Menoufia University, Egypt

Department of [4]Otorhinolaryngology, Armed Forces College of Medicine, Egypt

***Corresponding author:** Ola Taher Ismail Allam, **Mobile:** (+20) 01093524109, **E-mail:** olaallam2020@gmail.com

ABSTRACT

Background: Thyroid nodules are common in the population, and it's still unclear how to choose which thyroid nodules to send for fine needle aspiration cytology (FNAC).

Objective: To evaluate the concordance between the ACR Thyroid Imaging Reporting and Data System (TIRADS) and fine-needle aspiration (FNA) based cytology reports using UK RCPath Thy classification in patients with thyroid nodules, aiming to decreasing the unnecessary fine-needle aspiration biopsy (FNAB) of thyroid nodules.

Patients and methods: This retrospective cross-sectional study was conducted on patients who were referred to Menoufia University Hospitals for thyroid gland sonography and FNA with sonography guidance. Eighty patients were enrolled in this study.

Results: This study involved 80 patients, 92.5 % were females and 7.5% were males with a mean age of 45.5±13.5. Sixty percent of the patients had TIRADS 3, 35% had TIRADS 4 and 5% had TIRADS 5. Fifty seven percent of the patients had Thy 2, 16.25 % had Thy 3 (3 cases were Thy3a and 10 cases were Thy 3f) and 26.25 % were Thy 4. Risk of malignancy was 14.5%, 35.7% and 100% for TIRADS 3, TIRADS 4 and TIRADS 5, respectively. Twenty-one cases were positive for malignancy by Thy classification, 71.4% (15/21) of these cases was positive for malignancy by TIRADS classification with significant p-value (0.001) and 0.365 Kappa agreement.

Conclusions: This study revealed that there was a fair agreement between TIRAD and Thy system in evaluation of thyroid nodules and both are necessary for proper management of patients. TIRADS can be relied upon for follow up of patients and in cases of small nodules not accessible for FNAC.

Keywords: Thyroid nodules, TIRADS, Thy classification, FNA.

INTRODUCTION

The prevalence of thyroid nodules in the general population is 2-6% by palpation and 19-35% by ultrasound examination. Thyroid nodules are a common condition. They are defined as focal thyroid regions with altered echogenicity that can be identified radiographically [1]. Although the majority of thyroid nodules are benign, 5-15% of them were found to be cancerous [2].

High-definition ultrasonography is recommended for clinically detectable nodules in euthyroid patients. **Horvath *et al.*** developed a TIRADS in 2009, which was recognized and later proposed by the ACR. TIRADS is classified into five categories depending on the distribution of US features (composition, echogenicity, shape, margin, and echogenic foci) [3].

The recommended malignancy risk in each category is as follows: ≤2% for TIRADS 1 and 2, ≤5% for TIRADS 3, 5%-20% for TIRADS 4, and >20% for TIRADS 5 [4].

FNAC of thyroid nodules provides an appropriate treatment plan and, if necessary, the correct surgical procedure [4,5].

Aim of this study was to evaluate the concordance between the ACR TIRADS and FNA based cytology reports using UK RCPath Thy classification in patients with thyroid nodules, aiming to decreasing the unnecessary FNAB of thyroid nodules.

PATIENTS AND METHODS

This retrospective cross-sectional study was conducted on patients who were referred to Menoufia University Hospitals for thyroid gland sonography and FNA with sonography guidance. Patients with thyroid nodules found by ultrasonography or palpated and referred by a doctor met the inclusion criteria. However, participants who had a prior diagnosis of thyroid cancer or their TIRADS was 1 or 2 as determined by US, were not allowed to participate in the trial. Eighty patients were enrolled in this study.

Thyroid ultrasound:

Thyroid ultrasound examination was done, using a high-resolution (7.5–15- MHz) linear-array transducer (GE Logic E10, TOSHIBA APLIO, USA) A Scanners including transverse and longitudinal thyroid gland scanning using the brightness B-mode and color-coded Doppler imaging for all cases. We examined the ultrasonography results of the nodules using the ACR-TIRADS rating system.

Image analysis:

Five different items of ultrasonography results were used to calculate TIRADS scoring. The malignancy rate and TR (TIRADS) category were correlated with the cumulative score. The thyroid nodule's composition, echogenicity, transverse plane shape assessment, size, borders, and echogenic foci with

Received: 18/03/2024
Accepted: 16/05/2024

calcifications found are among these radiologic items [6].

Scores 1-3 on the TIRADS were considered negative for malignancy, whereas scores 4 and 5 were malignant. One score is allocated to each of the following categories [6]:

•**Composition:** (i) Cystic or completely cystic: 0 points. (ii) Spongiform: 0 points. (iii) Mixed cystic and solid: 1 point. (iv) Solid or almost completely solid: 2 points.

•**Echogenicity:** (i) Anechoic: 0 points. (ii) Hyper- or isoechoic: 1 point. (iii) Hypoechoic: 2 points. (iv) Very hypoechoic: 3 points.

• **Shape:** (assessed on the transverse plane): (i) Wider than tall: 0 points. (ii) Taller than wide: 3 points

• **Margin**: (i) Smooth: 0 points. (ii) Ill-defined: 0 points. (iii) Lobulated/irregular: 2 points. (iv) Extra thyroidal extension: 3 points.

• **Echogenic foci:** (choose one or more): (i) None: 0 points. (ii) Large comet tail artifact: 0 points. (iii) Macro-calcifications: 1 point. (iv) Peripheral/rim calcifications: 2 points. (v) Punctate echogenic foci: 3 points

Scoring and classification [6]:

TR 1	TR 2	TR 3	TR 4	TR 5
0 points Benign	**2 points** Not suspicious	**3 points** Mildly suspicious	**4-6 points** Moderately suspicious	**≥7 points** Highly suspicious

Ultrasound (U/S) guided FNAC of thyroid nodules:

After giving their permission, the patients had FNA; they were then sent to lay down with their necks slightly stretched. Following localization of the lesion, the surrounding skin was cleaned with a 10% povidone-iodine solution and covered. For US, a high-resolution (7.5–15 MHz) linear array transducer was utilized, and its head was covered with sterile material. Throughout the process, a local anesthetic was utilized. An attached 5-mL syringe was used with a 22–23-gauge needle. Right over the lesion is where the transducer was positioned. The patient was instructed not to swallow or speak during the insertion of the needle. The biopsy method employed was freehand. At least two attempts were made to aspirate. The gathered material was spread out onto glass slides, fixed in 70% ethyl alcohol, and covered. Any material left over for cell blocking was obtained by rinsing the syringe with regular saline solution.

Cytopathology:

The specimens were received as air dried smeared slides with or without enclosed cell block. The slides were rapidly immersed in alcohol 95%. The slides then were submitted to hematoxylin and eosin staining while the enclosed cell block was submitted to routine tissue processing with paraffin embedded block formation. The prepared slides were examined by pathologist and interpreted according to royal college of pathologists Thy grading system. This system is formed of six categories which are [7]:

Thy 1: Non-diagnostic for cytological diagnosis (Thy1c: Non-diagnostic for cytological diagnosis – cystic lesion).

Thy 2: Non-neoplastic (Thy2c: Non-neoplastic, cystic lesion).

Thy 3a: Neoplasm possible – atypia/non-diagnostic.

Thy 3f: Neoplasm possible, suggesting follicular neoplasm.

Thy 4: Suspicious of malignancy.

Thy 5: Malignant.

Ethical approval:

Our institution's Ethical Committee Faculty of Medicine, Menoufia University, supervised and authorized all research methods. All the participants in the current study gave written, informed consent for their data to be published. The Helsinki Declaration was adhered to at every stage of the investigation.

Statistical analysis

Version 26.0 of SPSS was used to statistically evaluate the results. The X^2-test was used to examine the qualitative variables, which were expressed as number (N) and percentage (%). The mean ± standard deviation (SD) and range were used to express quantitative data. At the 0.05 levels, the two-tailed p-value was considered significant.

Risk of malignancy (ROM) was calculated as follows:

$$\frac{\text{No of cases turned out to be malignant on HP in each category}}{\text{No of cases in each category}} \times 100\%$$

RESULTS

Our studied 80 patients were 6 males and 74 females, their mean age was 45.5±13.5 years. Fifty- two patients complained of neck swelling (**Table 1**).

Table (1): Socio-demographic and clinical data (N= 80)

	Distribution (N=80)	
Age (years):		
Mean± SD	45.5±13.5	
Range	14-71	
	N	**%**
Gender:		
Male	6	7.5
Female	74	92.5
Complaint:		
Neck swelling	52	65.0
Incidental	18	22.5
Abnormal thyroid function	10	12.5

Regarding the ultrasound criteria for different thyroid nodules, the size of the nodules ranged from 4 mm to 60 mm. Forty-two nodules out of 80 were isoechoic. Sixty five percent of the nodules were solid nodules. Ninety five percent of the nodules had smooth margin. 80% had no calcification. Sixty-six cases of the nodules had intra-lesional vascularity and all the nodules had perilesional vascularity on color Doppler study. Sixty percent of the patients had TR3 (**Table 2** and **Fig. 1)**.

Table (2): US finding nodular data

	Distribution (N=80)	
	N	**%**
TIRADS grading:		
3	48	60%
4	28	35%
5	4	5%
Size (mm) for 78 cases:		
Mean± SD	24.6±11.5	
Range	4.0 - 60.0	
Echogenicity:		
Hyper-echoic	6	7.5
Hypo-echoic	10	12.5
Iso-echoic	42	52.5
Heterogeneous	22	27.5
Composition:		
Mixed solid and cystic	28	35.0
solid	52	65.0
Margin:		
Irregular	4	5.0
smooth	76	95.0
Echogenic foci:		
Macro-calcification	6	7.5
Peripheral calcification	2	2.5
Punctate calcification	8	10.0
No**ne**	64	80.0
Shape		
Wider than taller	80	100
Taller than wider	0	0
Doppler results:		
Intra- and peri-nodular of low velocity	66	82.5
Peri-nodular	14	17.5

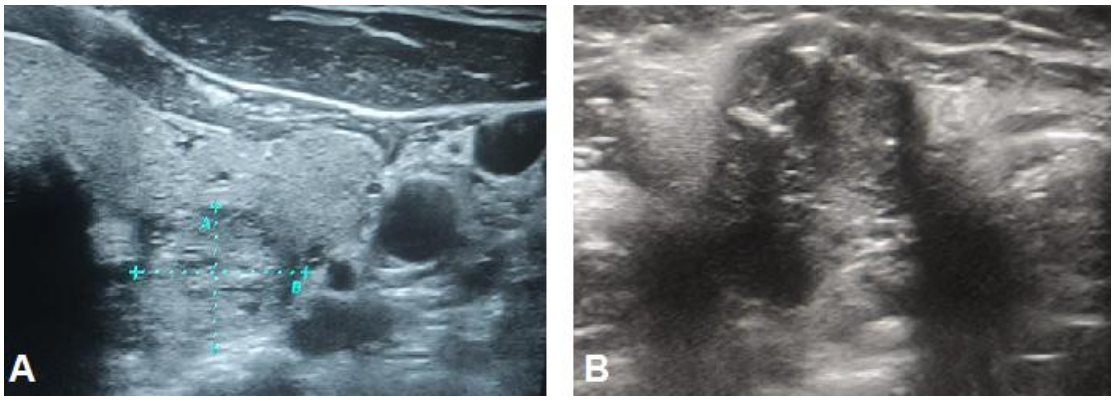

Fig. (1): Different thyroid nodules by US. (**A**) TR3 thyroid nodule and (**B**) TR5 thyroid nodule.

Cytological findings revealed that 57% of the nodules were Thy 2, 16.25% were THY 3 (3 cases Thy 3a and 10 cases were Thy 3f and 26.25% were Thy 4 [**Fig. 2 and 3 and table 3**]).

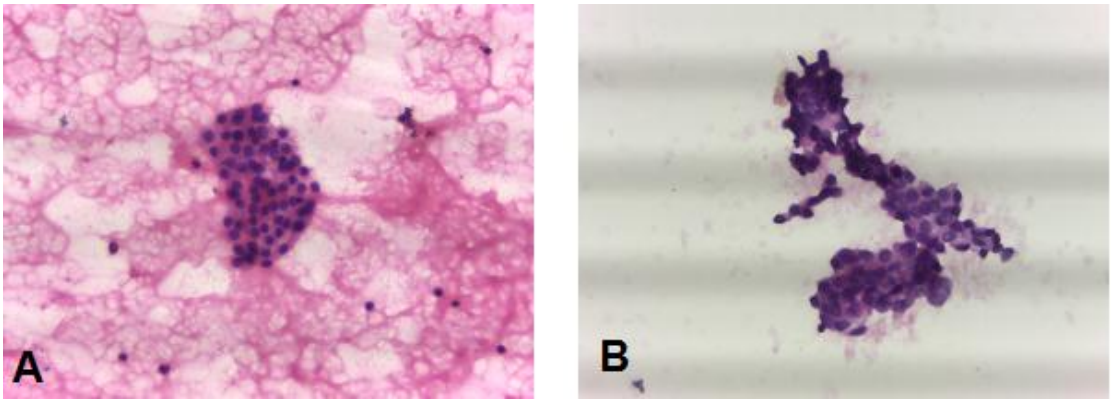

Fig. (2): Cytology of different thyroid nodules. (A) Thy 2 nodule: Smears examined showed cluster of monolayered sheets of follicular epithelial cells that showed rounded evenly spaced nuclei lacking features of papillary thyroid carcinoma (Thy 2) (hematoxylin and eosin staining x 200). (B) Thy 4 nodule: Smears examined showed clusters of follicular epithelial cells with attempt of papillae formation, the cells are ovoid with crowded nuclei that showed grooves and inclusions. (Thy 4, suspicious of papillary thyroid carcinoma) (hematoxylin and eosin staining x 200).

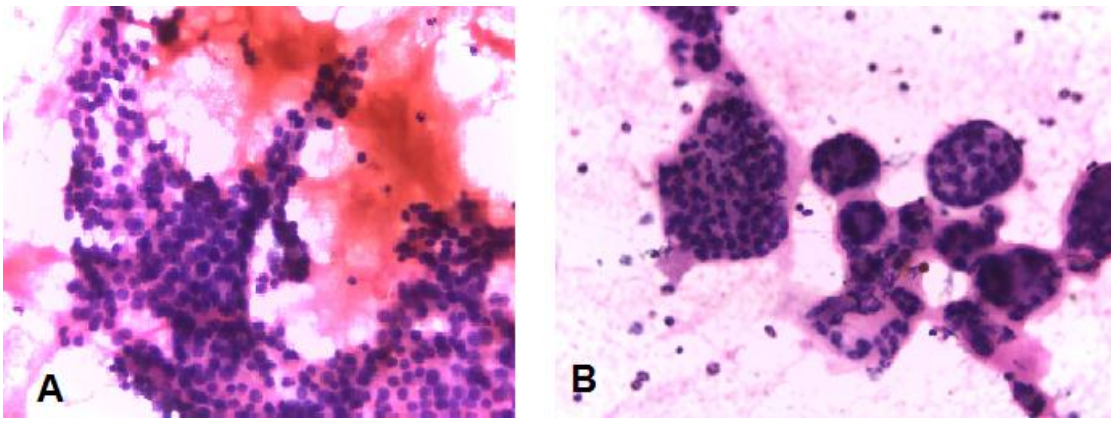

Fig. (3): Cytology of different thyroid nodules. (**A**)Thy 3a nodule: Smears examined showed sheets of follicular epithelial cells, some showed ovoid nuclei and others showed round nuclei with occasional grooving and crowdedness (Thy3 a) (hematoxylin and eosin staining x 400). (**B**)Thy 3f nodule: Smears examined showed follicular epithelial cells arranged into sheets, simple and complex follicles assigned as follicular neoplasm (Thy 3f) (hematoxylin and eosin staining x 400).

Table (3): Cytology of the thyroid nodules

UK RCPath (Thy classification)	N	%
Thy 1	0	0.0
Thy 2	46	57.5
Thy 3	13	16.25
Thy 4	21	26.25
Thy 5	0	0.0

Thirty-four cases (70.8%) of TR3 cases were diagnosed as THY 2, 14.6% were Thy 3 and 14.6% were Thy 4, while 42.9% of patients with TR4 nodules were Thy 2, 21.4 % were Thy 3 and 35.7% were Thy 4. All nodules with TR5 classification were Thy 4 in cytology. Risk of malignancy was 14.6%, 35.7% and 100% for TR3, TR4 and TR5, respectively (**Table 4**).

Table (4): Correlation between TIRADS and Thy classifications

	TIRADS						Total (N=80)	
	TR3 (N= 48)		TR4 (N= 28)		TR5 (N= 4)			
	N	%	N	%	N	%	N	%
Thy classifications								
Thy 2	34	70.8	12	42.9	-	-	46	57.5
Thy 3	7	14.6	6	21.4	-	-	13	16.25
Thy 4	7	14.6	10	35.7	4	100	21	26.25

Regarding the concordance between TIRADS and Thy classification, 21 cases were positive for malignancy by Thy classification, 71.4% of these cases were positive for malignancy by TIRADS classification with significant p-value and fair Kappa agreement (0.653) (**Table 5**).

Table (5): Concordance between TIRADS and THY classifications

	THY				Kappa agreement (P-value)
	Positive (N= 21)		Negative (N= 59)		
	N	%	N	%	
TIRADS:					
Positive	15	71.4	17	28.8	0.365
Negative	6	28.6	42	71.2	**(0.001)**

DISCUSSION

The prevalence of thyroid cancer has increased noticeably, which may be linked to the extensive use of neck ultrasonography and sonar-guided FNAC surveillance of thyroid nodules [1]. It was challenging to achieve a balance between not missing malignant thyroid nodules and not performing unnecessary FNA while looking for malignant lesions that required surgery[2].

The ACR-TIRADS system has helped to standardise the terminology used by doctors to discuss thyroid ultrasonography results and has given important information about the treatment strategy [2,5]. With the growing knowledge of thyroid illnesses, FNAC plays a critical role in the triage of patients into operational and non-operative categories [8].

Males are more likely than females to have thyroid nodules, while females are more likely to develop cancer [9]. In the present study, 92.5 % were female patients, consistent with finding in multiple other studies [2,10,11]. Sixty percent of the patients were TR3, 35% were TR4 and 5% were TR5, that agreed with **Periakaruppan *et al.*** [12] who found that 92% of the nodules were TR2 and TR3. However, that was against **Foroughi *et al.*** [10] study who found that most patients had TR4 (53.5 %) followed by TR3.

As regards the RCPath Thy classification, in this study 57.5% of the patients had Thy 2 followed by Thy 4 (26.25%) then Thy 3 (16.25%), this was in concordance with **Foroughi *et al.*** [10] who found that about 82.6% of the patients lies in Bethesda II classification (corresponding to Thy 2). Among the 48 nodules were labeled as TR3, 34 nodules (70.8 %) were in Thy 2 classification, 7 nodules were labeled as Thy 3 and 7 nodules were labeled as Thy 4 classification. This was in agreement with **Periakaruppan, *et al.*** [12] who found that most of TR3 nodules (93%) were labeled as Bethesda II classification (corresponding to Thy 2).

In the current study, 35.7 % of the nodules labeled as TR4 were designated as Thy 4 classification and 42.9% proved to be Thy 2. While all 4 nodules labeled as TR5 proved to be Thy 4 classification. Considering all nodules, the risk of malignancy for TR3, TR4 and TR5 were 14.6%, 35.7% and 100%, respectively, however the recommended risk of malignancy for TR3, TR4 and TR5 of ACR-TIRADS are < 5%, <20% and >20%, respectively [6].

Dy *et al.* [13] found that the risk of malignancy for TR3 is 12.5%, and **Hussein *et al.*** [2] found it to be about 14.5%. **Yoon *et al.*** [14] described the risk of malignancy for TR5 as 92.3%. Finally, this study revealed that of the 32 nodules that were positive for malignancy by TIRADS classification, only 21 nodules were positive by cytology using Thy classification and that of the 48 nodules negative for malignancy by TIRADS classification, only 6 nodules were positive by cytology using Thy classification with fair Kappa agreement (0.365) and significant P value (0.001).

CONCLUSION

This study revealed that there was a fair agreement between TIRAD and Thy system in evaluation of thyroid nodules and both are necessary for proper management of patients. TIRADS can be relied upon for follow up of patients and in cases of small nodules not accessible for FNAC.

REFERENCES

1. **Niedziela M (2014):** Thyroid nodules. Best Practice & Research Clinical Endocrinology & Metabolism, 28(2): 245–277.
2. **Hussein M, Elesawy Y, Ghoweba D *et al.* (2024):** Correlation of ultrasound features in the TIRADS scoring system with cytological findings in the FNAC of thyroid nodules and their association with the metabolic status. Egypt J Intern Med., 29: 36. doi.org/10.1186/s43162-024-00290-z.
3. **Horvath E, Majlis S, Rossi R *et al.* (2009):** An ultrasonogram reporting system for thyroid nodules stratifying cancer risk for clinical management. J Clin Endocrinol Metab., 94(5):1748–1751.
4. **Xu T, Wu Y, Wu R *et al.* (2019):** Validation and comparison of three newly-released Thyroid Imaging Reporting and Data Systems for cancer risk determination. Endocrine, 64(2): 299–307.
5. **Kwak J, Han K, Yoon J *et al.* (2011):** Thyroid imaging reporting and data system for US features of nodules: a step in establishing better stratification of cancer risk. Radiology, 260(3): 892–899.
6. **Tessler F, Middleton W, Grant E *et al.* (2017):** ACR Thyroid Imaging, Reporting and Data System (TI-RADS): White Paper of the ACR TI-RADS

Committee. Journal of the American College of Radiology, 14(5): 587–595.

7. **Cross P, Chandra A, Giles T *et al.* (2016):** Guidance on the reporting of thyroid cytology specimens. The Royal College of Pathologists, pp. 1-22. https://www.rcpath.org
8. **Lin J, Chao T, Huang B *et al.* (2005):** Thyroid cancer in the thyroid nodules evaluated by ultrasonography and fine-needle aspiration cytology. Thyroid, 15(7): 708–717.
9. **Rahbari R, Zhang L, Kebebew E (2010):** Thyroid cancer gender disparity. Future Oncology, 6(11): 1771–1779.
10. **Foroughi A, Mokhtari M, Heidari E *et al.* (2022):** Concordance between TIRADS and Cytology in Thyroid Nodule. Iranian Journal of Otorhinolaryngology, 34(125): 295–302.
11. **Okasha H, Mansor M, Sheriba N *et al.* (2021):** Role of elastography strain ratio and TIRADS score in predicting malignant thyroid nodule. Archives of Endocrinology and Metabolism, 64(6): 735–742.
12. **Periakaruppan G, Seshadri K, Vignesh Krishna G *et al.* (2018):** Correlation between Ultrasound-based TIRADS and Bethesda System for Reporting Thyroid-cytopathology: 2-year Experience at a Tertiary Care Center in India. Indian Journal of Endocrinology and Metabolism, 22(5): 651–655.
13. **Dy J, Kasala R, Yao C *et al.* (2017):** Thyroid Imaging Reporting and Data System (TIRADS) in stratifying risk of thyroid malignancy at The Medical City. J ASEAN Fed Endocr Soc., 32(2): 108–116.
14. **Yoon J, Lee H, Kim E *et al.* (2016):** Malignancy Risk Stratification of Thyroid Nodules: Comparison between the Thyroid Imaging Reporting and Data System and the 2014 American Thyroid Association Management Guidelines. Radiology, 278(3): 917–924.