BENHA MEDICAL JOURNAL bmj

Print ISSN 1110-208X.

Online ISSN 2357-0016

Original article

Sonographic Evaluation of Non-Palpable Thyroid Nodule, Correlated with FNA

Hamada M. Khater, Hanady F. Mahmoud, Mariam H. Afifi

Radiodiagnosis Department, Faculty of Medicine Benha University, Egypt.

Corresponding to: Hanady F. Mahmoud, Radiodiagnosis Department, Faculty of Medicine Benha University, Egypt.

Email: hanafouad33@gmail.com

Received: 26 December 2024

Accepted: 3 January 2025

Abstract:

Background: Thyroid nodules are common findings, often incidentally detected through imaging. Accurate differentiation between benign and malignant nodules is essential to guide management. The Thyroid Imaging Reporting and Data System (TIRADS) offers a standardized approach to assess malignancy risk using ultrasound, while fine-needle aspiration cytology (FNAC) provides histopathological confirmation. Objective: This study aimed to evaluate the diagnostic accuracy of TIRADS in identifying malignant thyroid nodules and correlate its findings with FNAC results. **Method:** This prospective cross-sectional study was conducted from November 2023 to September 2024 at Benha University Hospital and General Mahalla Hospital. A total of 50 patients (6 males and 44 females) aged 18–75 years with incidentally detected thyroid nodules on imaging were included. All nodules underwent sonographic evaluation using TIRADS classification and ultrasound-guided FNAC. Statistical analysis assessed the diagnostic performance of TIRADS, with histopathological FNAC findings as the reference standard. **Results:** Of the 50 nodules, 62% were benign, while 38% were malignant based on FNAC findings. TIRADS demonstrated an overall diagnostic accuracy of 88%, with a sensitivity of 84.21% and a specificity of 90.32%. Malignant nodules were significantly associated with higher TIRADS categories, particularly TIRADS 5 ($p < 0.001$). **Conclusion:** TIRADS provides a reliable, non-invasive tool for assessing the malignancy risk of thyroid nodules. Its high accuracy, sensitivity, and specificity make it a valuable complement to FNAC in the diagnostic evaluation of thyroid nodules, aiding in clinical decision-making.

Key words: Sonographic evaluation, thyroid nodule, fine-needle aspiration cytology, imaging.

Introduction

Thyroid nodule is a discrete lesion in the thyroid gland that is radiologically distinct from the surrounding thyroid parenchyma [(1)].

Thyroid nodules are common. Their prevalence can be affected by several factors, such as iodine sufficiency status and age, and detection rates differ according to the modality of imaging used and the experience of the operator [(2)].

Ultrasound (US) is the first-line imaging modality for malignancy risk assessment of thyroid nodules. Specific US features, such as hypoechogenicity, taller-than-wide shape on transverse view, irregular margins, microcalcifications, and extrathyroidal extension, are recognized to be associated with cancer [(3)]

The 2015 ATA guidelines recommend the use of FNAC for nodules ≥ 1.5 cm, or for nodules ≥ 1.0 cm if they have high or intermediate risk sonographic characteristics [(4)]. There is no evidence that routine investigation of suspicious nodules < 1.0 cm improves outcomes [(5)].

Therefore, this study aims to evaluate non –palpable thyroid nodule detected incidentally and correlated with histopathological findings detected by fine needle aspiration (FNA) to differentiate between benign and malignant.

Patients and Methods

Study design

This is a prospective cross sectional diagnostic accuracy study done at Radiology Department in Benha University Hospital and General Mahalla Hospitals.

Target population

The study was conducted on 50 patients who were admitted to the hospital with incidental thyroid nodules on different radiological imaging like CT and US and a candidates for thyroid FNAC, during the period from November 2023 to September 2024. The main inclusion criteria were patients age between 18 to 80 years old, however patient who previously diagnosed or treated with thyroid lesions, patient with clinical or serological proven nodular goiter, patient with contraindication for minimally invasive surgical procedures, or with bleeding tendency and who refused to participate in the study were excluded from the study.

Ethical consideration

This study received approval from research Ethical Committee of Benha Faculty of Medicine with code **(MS 45-12-2023)**.

Procedure

All the study patients underwent superficial ultrasound examination of the thyroid gland with linear probe (5-12MHz). logic p5 sonographic device. The patient who has incidentally discovered thyroid nodules are selected and TIRADS classification for each nodule is calculated. All patients who undergone FNAC with no contraindications – were selected in the study sample. The neck US –guided FNA was carried out using a 23-G Needle and 5 ml syringe. The samples were then spread on the slides and fixed using 100% alcohol, and lastly, the slides were examined by cytologist.

Data management

Numerical data were statistically described in terms of mean ± standard deviation (± SD), while categorical data were described using frequencies (number of cases) and percentages. All statistical calculations were done using computer program SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 27, and Medcalc version 22.18 (copyright © 1993-2024, medcalc software Ltd). The accepted level of significance was 0.05. TIRADS scores 4 and 5 were considered positive for malignancy, while scores 1–3 was considered negative for malignancy. Cross-tabulation of TIRADS [(6)]

Results

The study included 50 cases (6 males and 44 females) with mean age of 40.84 ± 12.34 years with range between 18 and 75 years. The age group between 41 and 50 years was the most common age group representing 34% of the cases (Table 1).

According to the pathological nature of the lesions in the cases of the study, there were 31 benign nodules (62%) and 19 (38%) malignant nodules. The pathological analysis showed colloid nodules in 15 cases (30%), follicular adenoma in 6 cases (12%), FTC in 2 cases (4%), hyperplastic nodules in 13 cases (26%) and PTC in 14 cases (28%) (Table 1).

Table (2) shows that all the nodules with TIRADS 1 and TIRADS 2 were benign. In TIRADS 3 there were 18 benign and 3 malignant nodules. In TIRADS 4 there were 2 benign nodules and 3 malignant nodules while in TIRADS 5, there were 1 nodule benign and 13 malignant nodules. There was a high statistically significant difference between the two groups ($P < 0.001$).

The diagnostic accuracy of TIRADS was compared to the FNAC for the 50 studied patients. TIRADS could correctly detect the presence of malignancy in 16 cases, however FNAC proved presence of the malignancy in 19 cases, with a sensitivity of = 84.21% (95%CI=60.42% to 96.62%). Moreover, TIRADS gave positive malignancy findings in 3 cases, which was identified as false results later by FNAC, with a specificity of 90.32% (95%CI=74.25% to 97.96%). The calculated overall accuracy of the TIRADS was 88.0% (95%CI=75.69% to 95.47%) (Table 3).

Table (1): Demographic data, analysis of the final diagnosis in the cases of the study

Variables	**Study cases N = 50**	
Sex		
Male		**6 (12%)**
Female		**44 (88%)**
Age (years)		
Mean ± SD		**40.84 ± 12.34**
Median (range)		**41 (18 -75)**
Age group (Years)		
≤ 20		**4 (8%)**
21-30		**5 (10%)**
31-40		**14 (28%)**
41-50		**17 (34%)**
51-60		**7 (14%)**
61-70		**2 (4%)**
> 70		**1 (2%)**
Final diagnosis		
Colloid nodule	**15**	**30 %**
Follicular adenoma	**6**	**12 %**
FTC	**2**	**4 %**
Hyperplastic nodule	**13**	**26 %**
PTC	**14**	**28 %**
Nature of the nodule		
Benign	**31**	**62 %**
Malignant	**19**	**38 %**

Table (2): Relation between the nature of the nodules and TIRADs

	Nature		Risk of malignancy	Test of significance
	Benign (n= 31)	Malignant (n= 19)		
TIRADs 1	3 (9.7%)	0 (0%)	0 %	
TIRADs 2	7 (22.6%)	0 (0%)	0 %	MC =
TIRADs 3	18 (58.1%)	3 (15.8%)	14.3 %	30.051 P <
TIRADs 4	2 (6.5%)	3 (15.8%)	60 %	0.001*
TIRADs 5	1 (3.2%)	13 (66.4%)	92.9 %	

P: probability. Categorical data expressed as Number (%) MC: Monte-Carlo test
*: significant value < 0.05

Table (3): Diagnostic performance of TIRADS compared with FNAC findings

Parameters		FNAC finding		
		Malignant (n=19)	Benign (n=31)	Total examined cases (n=50)
US finding (TIRADS)	Malignant look	16 (TP)	3 (FP)	19
	Benign look	3 (FN)	28 (TN)	31
Final TIRADS findings				
Sensitivity= 84.21% (95%CI=60.42% to 96.62%)		PVP= 84.21% (95%CI=64.13% to 94.09%)	Positive Likelihood Ratio= 8.70 (95%CI= 22.92 to 25.96)	Overall accuracy of TIRADS=88.0% (95%CI=75.69% to 95.47%)
Specificity= 90.32% (95%CI=74.25% to 97.96%)		PVN = 90.32% (95%CI=76.65% to 96.37%)	Negative Likelihood Ratio= 0.17 (95%CI=0.06 to 0.50)	

Case scenarios

- Case 1: (Table 4, Figure 1)
- Case 2: (Table 4, Figure 2)
- Case 3: (Table 4, Figure 3)

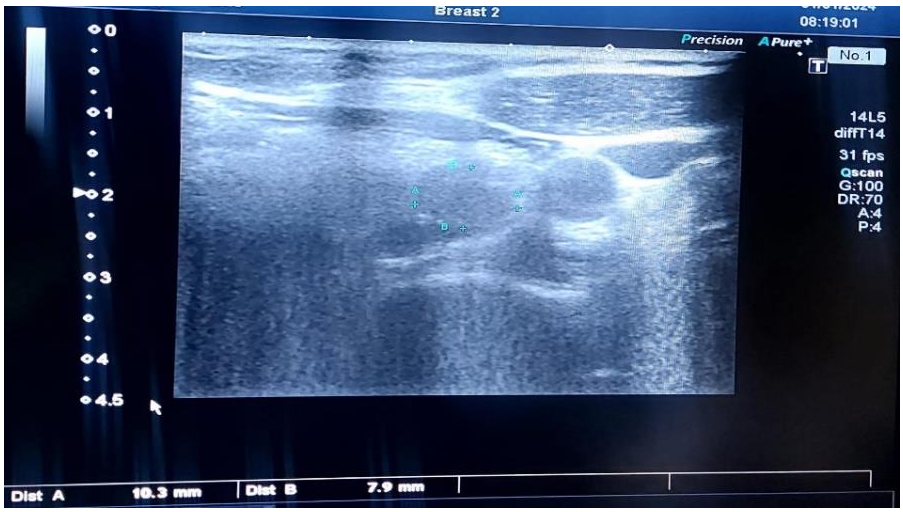

Figure 1: TIRADS score: TR5 highly suspicious, Pathology diagnosis: Bethesda IV follicular neoplasm.

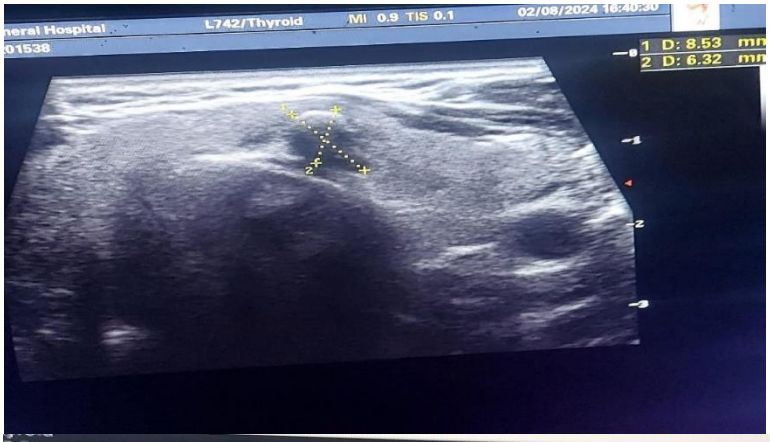

Figure 2: TIRADS score: TR2, Pathology diagnosis: BethesdaII benign (colloid cyst).

Figure 3: TIRADS score: TR3, Pathology diagnosis: Bethesda II (Follicular adenoma).

Table 4: Ultrasound Findings of cases.

Case 1		
Category	Description	Points
Composition	Solid	2
Echogenicity	Hypoechoic	2
Shape	Wider than tall	0
Margin	Smooth	0
Echogenic foci	Yes	3
	Total score	7
Case 2		
Category	Description	Points
Composition	Cystic	0
Echogenicity	Anechoic	0
Shape	Wider than tall	0
Margin	Smooth	0
Echogenic foci	Peripheral rim calcification	2
	Total score	2
Case 3		
Category	Description	Points
Composition	Solid	2
Echogenicity	Isoechoic	1
Shape	Wider than tall	0
Margin	Smooth	0
Echogenic foci	NO	0
	Total score	3

Discussion

The thyroid nodule (TN) is a discrete lesion that could be distinct radiologically and pathologically from the normal thyroid parenchyma. It is considered the most common abnormality in the endocrine system [7]. The estimated prevalence of thyroid nodules ranges from 4% [by clinical examination] to 67% by ultrasonography. In addition, about 50% of adults had non-palpable nodules that discovered in autopsy [8].

The current goal in the TN evaluation is to determine whether it is benign or malignant. Unfortunately, approximately 25% of all biopsies have indeterminate cytology [9].

Usually, the US is the first choice among the imaging studies during TN assessment followed by ultrasound-guided fine-needle aspiration biopsy (FNAB), and mostly the surgery decision or leaving the nodule alone is dependent on the FNAB result. However, FNAB has several limitations including inadequate sampling, operator dependency, and false negative cytology rates (10–30%) [10-13].

A practical thyroid imaging reporting and data system (TIRADS) for thyroid nodules has been proposed to classify nodules of the thyroid gland to solve the problem of nodule selection for fine needle aspiration cytology (FNAC). One of the recent studies revealed the fact that 7.3% of malignant nodules did not have suspicious malignant features on ultrasound [14].

This study was conducted to evaluate non –palpable thyroid nodule detected incidentally and correlated with histopathological findings detected by fine needle aspiration (FNA) to differentiate between benign and malignant.

The study included 50 cases (6 males and 44 females) with mean age of 40.84 ± 12.34 years with range between 18 and 75 years. The age group between 41 and 50 years was the most common age group, representing 34% of the cases.

This result is comparable to Fawzy et al. [15] who found that there was female predominance [83.2%] [15].

De et al. (16) found that thyroid nodules were commonly seen in females, suggestive of female predominance [86.86% of the total study population [N = 137]] [16].

In another Egyptian study, a total of 40 patients were included in the study, seven males (17.5%) and 33 females (82.5%). The mean patient age was 44.48 ± 11.04 years old (range 25–69 years) [17].

Horvath et al. (18) included total of 502 nodules (in 210 patients) and out of the total number of patients, 164 were women (78.1 % of the sample group) [18].

In another study, thyroid ultrasound was performed in 450 patients (350 females and 100 males), and their age ranged between 10 and 70 years with a mean of 38.7 ± 15.7 years [19].

Dawoud and Dawoud [20] included 60 patients (37 females and 23 male) with solitary thyroid nodule were included, their age ranged from 21 to 52 years (mean age 30.6 years) [20].

As reported in all the previous results including the results of this current study, thyroid nodules is more common in females however, the risk of malignancy of the thyroid nodules is more common in male gender [21].

In the current study, regarding the pathology of the thyroid nodules, there were 31 benign nodules (62%) and 19 (38%) malignant nodules.

Comparable data was reported by Dy et al. [22] who found benign lesions among 66.4% of cases [22].

In the study done by Fawzy et al., [15] 73.2% were benign and 26.8% were malignant by surgical biopsy [15]. In Jabar et al.'s results. They found that after surgery, 81.8% were benign and 18.9% were malignant [23]. These difference in the incidence of malignant cases could be attributed to the different sample size and racial issues that control neoplastic behaviour of the cell [24].

This came in agreement with Afifi et al. who revealed that 42% of the included thyroid nodules were malignant. Our results are also matching with 21–54% in previous studies [25- 27]. Abodewan et al. [28], estimated higher prevalence of malignancy of 62.2% [28].

This current study showed that the sensitivity and specificity of TIRADS was 84.21%, and 90.3% respectively. The overall accuracy was 88.0%.

In the same line of this current study, Periakaruppan et al., [6] found that 92.3% sensitivity, and 94.15% specificity. Periakaruppan et al., [6] claimed that there were 12 true positive cases, 10 false negative cases, while there were 161 true negative cases and 10 false positive.

Against our study, Dy et al., 2017 [22], proved that TIRADS 4a to 5 classes had approximately 98% sensitivity, 7.07% specificity, PPV of 34.75%, NPV of 87.5%, and accuracy of 53%. Also, unlike our study, De et al., 2020 [16] claimed that the sensitivity, specificity, PPV, and NPV of TIRADS versus histopathology were respectively 80%, 47.2%, 51.28%, and 77.27%. The overall accuracy of ultrasound was 61%.

The variation of diagnostic performance of TIRADS across different studies could be due to any factors. First, the design of individual studies and the population characteristics can significantly influence the outcomes of both TIRADS and FNAC: Second, Sample size may play role. Smaller studies may have limited statistical power, leading to variability in the reported performance of TIRADS and FNAC. Larger, multi-center studies often provide more reliable estimates. Third, the variability in ultrasound techniques and the experience of the sonographer can lead to discrepancies in TIRADS classification. Differences in ultrasound equipment (e.g., high-frequency vs. low-frequency transducers) and protocols may impact on the quality of images and the ability to discern subtle features indicative of malignancy. The interpretation of ultrasound findings can be subjective, with differing levels of experience among practitioners leading to variability in TIRADS categorization. A study by Luo et al. [29] highlighted that inter-observer variability in ultrasound interpretation can lead to discrepancies in the classification of nodules. Fourth, the accuracy of FNAC is also influenced by the interpretation of cytological samples. The skill and experience of the pathologist interpreting FNAC samples can lead to variations in sensitivity and specificity. Highly experienced pathologists may achieve higher diagnostic accuracy compared to those with less experience. Certain thyroid conditions, such as follicular neoplasms, can present challenges in cytological assessment, leading to false negatives (missed malignancies) and false positives (benign conditions misclassified as malignant). The pathologist's ability to recognize atypical cells and the presence of diagnostic criteria for malignancy are critical factors. Fifth, the thresholds used to define malignancy in TIRADS and FNAC can also contribute to differences in performance. Different studies may employ varying thresholds for categorizing nodules as malignant or benign. For instance, some studies may classify indeterminate nodules as malignant based on specific ultrasound features, while others may require definitive histological evidence. The TIRADS classification system is subject to updates and refinements. Studies conducted before significant changes may report different sensitivity and specificity rates compared to more recent literature.

Conclusion

This study highlights the utility of the Thyroid Imaging Reporting and Data System (TIRADS) as an effective tool for the risk stratification of thyroid nodules. With an overall diagnostic accuracy of 88%, TIRADS demonstrates a high sensitivity and specificity in distinguishing

malignant from benign nodules, making it a valuable non-invasive method for initial assessment. The findings support the complementary role of TIRADS alongside fine-needle aspiration cytology (FNAC) in guiding clinical decisions. The significant correlation between higher TIRADS categories and malignancy risk underscores its importance in optimizing the management of thyroid nodules, potentially reducing unnecessary invasive procedures.

References

1. Nagarkar N M, Mehta R & Rao K N.. Thyroid Gland. In Atlas of Head Neck and Skull-base Surgery. Springer. 2023;(1):65-91.
2. Ospina N S, Iñiguez-Ariza N M & Castro M R. Thyroid nodules: diagnostic evaluation based on thyroid cancer risk assessment. BMJ. 2020;368.
3. Hoang J K, Middleton W D, Farjat A E, Teefey S A, Abinanti N, Boschini F J, et al. Interobserver variability of sonographic features used in the American College of Radiology Thyroid Imaging Reporting and Data System. American Journal of Roentgenology. 2018;211(1), 162-167.
4. Haugen B R. 2015 American Thyroid Association management guidelines for adult patients with thyroid nodules and differentiated thyroid cancer: what is new and what has changed? Cancer. 2017;123(3), 372-381.
5. van Gerwen M A, Tuminello S, Riggins G J, Mendes T B, Donovan M, Benn E K, et al. Molecular study of thyroid cancer in World Trade Center responders. International Journal of Environmental Research and Public Health. 2019;16(9), 1600.
6. Periakaruppan G, Seshadri K G, Krishna G V, Mandava R, Sai V P & Rajendiran S. 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. 2018;22(5), 651.
7. Xu C, Liu W, Chen Y & Ding X. A supervised case-based reasoning approach for explainable thyroid nodule diagnosis. Knowledge-Based Systems. 2022;251, 109200.
8. Harshvardhan R, Jorwal V, Gupta S, Sharma V, Sehra R & Agarwal S. Assessment of accuracy of fine needle aspiration cytology and ultrasonography in relation to histopathology in cases of solitary thyroid nodule. Indian Journal of Otolaryngology and Head & Neck Surgery. 2020;1-8.
9. Filho R H C, Pereira F L & Iared W. Diagnostic accuracy evaluation of two-dimensional shear wave elastography in the differentiation between benign and malignant thyroid nodules: systematic review and meta-analysis. Journal of Ultrasound in Medicine. 2020;39(9), 1729-1741.
10. Chernyavsky V S, Shanker B A, Davidov T, Crystal J S, Eng O, Ibrahim K, et al. Is one benign fine needle aspiration enough? Annals of surgical oncology. 2012;19(5), 1472-1476.
11. Choi Y J, Jung I, Min S J, Kim H J, Kim J h, Kim S, et al. Thyroid nodule with benign cytology: is clinical follow-up enough? PLoS One. 2013;8(5), e63834.
12. Mehrotra P, McQueen A, Kolla S, Johnson S & Richardson D. Does elastography reduce the need for thyroid FNA s? Clinical Endocrinology. 2013;78(6), 942-949.
13. Xia J, Chen H, Li Q, Zhou M, Chen L, Cai Z, et al. Ultrasound-based differentiation of malignant and benign thyroid Nodules: An extreme learning machine approach. Computer methods and programs in biomedicine. 2017;147, 37-49.
14. Giovanella L, Campennì A, Tuncel M & Petranović Ovčariček P. Integrated Diagnostics of Thyroid Nodules. Cancers. 2024;16(2), 311.
15. Fawzy M M, Harb D & Sheta H. Accuracy of Bethesda system in the diagnosis of thyroid nodules: Utility of combined histopathological and radiological reporting systems. International Journal of Cancer and Biomedical Research. 2021;5(4), 147-158.
16. De D, Dutta S, Tarafdar S, Kar S S, Das U, Basu K, et al. Comparison between sonographic features and fine needle aspiration cytology with histopathology in the diagnosis of solitary thyroid nodule. Indian Journal of Endocrinology and Metabolism. 2020;24(4), 349-354.
17. Azab E A, Abdelrahman A S & Ibrahim M E A. A practical trial to use Thyroid Imaging Reporting and Data System (TI-RADS) in differentiation between benign and malignant thyroid nodules. Egyptian Journal of Radiology and Nuclear Medicine. 2019;50(1), 17.
18. Horvath E, Silva C F, Majlis S, Rodriguez I, Skoknic V, Castro A, et al. Prospective validation of the ultrasound based TIRADS (Thyroid Imaging Reporting and Data System) classification: results in surgically resected thyroid nodules. European radiology. 2017;27(6), 2619-2628.
19. Ashamallah G A & EL-Adalany M A. Risk for malignancy of thyroid nodules: Cmparative

study between TIRADS and US based classification system. The Egyptian Journal of Radiology and Nuclear Medicine. 2016;47(4), 1373-1384.
20. Dawoud M M & Dawoud R M. Added value of strain elastosonography in prediction of malignancy in solitary thyroid nodule. The Egyptian Journal of Radiology and Nuclear Medicine. 2017;48(4), 905-912.
21. Batawil N & Alkordy T. Ultrasonographic features associated with malignancy in cytologically indeterminate thyroid nodules. European Journal of Surgical Oncology (EJSO). 2014;40(2), 182-186.
22. Dy J G, Kasala R, Yao C, Ongoco R & Mojica D J. Thyroid Imaging Reporting and Data System (TIRADS) in Stratifying Risk of Thyroid Malignancy at The Medical City. J ASEAN Fed Endocr Soc. 2017;32(2), 108-116.
23. Tessler F N, Middleton W D, Grant E G, Hoang J K, Berland L L, Teefey S A, et al. ACR thyroid imaging, reporting and data system (TI-RADS): white paper of the ACR TI-RADS committee. Journal of the American college of radiology. 2017;14(5), 587-595.
24. Acar Y, Doğan L, Güven H E, Aksel B, Karaman N, Özaslan C, et al. Bethesda made it clearer: A review of 542 patients in a single institution. Oncology Research and Treatment. 2017;40(5), 277-280.
25. Asteria C, Giovanardi A, Pizzocaro A, Cozzaglio L, Morabito A, Somalvico F, et al. US-elastography in the differential diagnosis of benign and malignant thyroid nodules. Thyroid. 2008;18(5), 523-531.
26. Ferrari F, Megliola A, Scorzelli A, Guarino E & Pacini F. Ultrasound examination using contrast agent and elastosonography in the evaluation of single thyroid nodules: Preliminary results. Journal of Ultrasound. 2008;11(2), 47-54.
27. Phuttharak W, Somboonporn C & Hongdomnern G. Diagnostic performance of gray-scale versus combined gray-scale with colour doppler ultrasonography in the diagnosis of malignancy in thyroid nodules. Asian Pac J Cancer Prev. 2009;10(5), 759-764.
28. Mohamed R E & Abodewan K A. Diagnostic utility of real-time ultrasound elastography for prediction of malignancy in solid thyroid nodules. The Egyptian Journal of Radiology and Nuclear Medicine. 2013;44(1), 33-43.
29. Luo Y, Jiang H, Xu W, Wang X, Ma B, Liao T, et al. Clinical, Pathological, and Molecular Characteristics Correlating to the Occurrence of Radioiodine Refractory Differentiated Thyroid Carcinoma: A Systematic Review and Meta-Analysis. Frontiers in Oncology. 2020;10.

To cite this article: Hamada M. Khater , Hanady F. Mahmoud, Mariam H. Afifi. Sonographic Evaluation of Non-Palpable Thyroid Nodule, Correlated with FNA. BMFJ 2025;42(6):117-125.