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Reliability of Thyroid Imaging Reporting and Data Systems' Scoring in the Evaluation of Thyroid Nodules

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Abstract

It is known that Thyroid Ultrasonography (US), guided by Fine Needle Aspiration (FNA), is a cost-effective and safe diagnostic method for evaluating thyroid nodules. Our purpose in the present study is to determine the reliability of the Thyroid Imaging Reporting and Data Systems (TIRADS) Scoring System for the evaluation of thyroid nodules. A total of 724 patients who were followed up in our endocrinology and general surgery clinic and operated on with the diagnosis of multinodular and nodular goiter were included in the study. The malignancy risk rate of all TIRADS categories was analyzed according to postoperative pathology results. Among the 724 patients, who were included in the study, preoperative FNA results were as 11.04% (n=80) benign, follicular, Hurthle cell neoplasia or suspected 8.83% (n=64), malignancy suspected 40.33% (n=292) and malignant 39.77% (n=288). We determined in the study that the malignancy was 72.15% (n=228) in TR-4 nodules and 97.1% (n=336) in TR-5 nodules. No correlations were detected between anti-TPO, anti-TG, TSH level, and malignancy. TIRADS Scoring System was successful in predicting malignancy rates in the present study.

Key words: *FNA biopsy, Risk assessment, Risk factors, TIRADS, Ultrasonography*

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Introduction

It is known that Thyroid Ultrasonography (US) guided by Fine Needle Aspiration (FNA) is a cost-effective and safe diagnostic method for evaluating thyroid nodules (1). It was shown that Thyroid FNA has a sensitivity of 65-99%, and a specificity of 72-100%, with a high positive predictive value (97-99%). However, with FNA, 10-42% of cases are detected as non-diagnostic in nodules and follicular lesions with unknown importance at 3-18% (2, 3). Despite these known limitations of FNA, the optimal management of these nodules has not yet been fully identified. Thyroid cancer has no typical sonographic model. Previous sonographic criteria were suggested to estimate malignancy risk in thyroid nodules (4). Thyroid Imaging Reporting and Data Systems (TIRADS) scoring methods (EU-TIRADS, ACR TI-RADS, and Kwak-TIRADS) based on nodule models by thyroid ultrasonography were published for risk classification of thyroid nodules (5-7). This scoring system identifies the thyroid nodule risk level according to appearance in ultrasonography. The risk of cancer in thyroid nodules is collected under five categories from TIRADS 1 to TIRADS 5. FNA and follow-up are recommended according to this risk status (8).

The present study aimed to determine ultrasonographic findings' diagnostic performance and reliability over TIRADS methods.

Methods

Ethics Committee Approval: This study was conducted in accordance with the ethical rules with the approval of Medicana International Samsun Hospital's clinical research ethics committee (Date: 20.04.2021, decision no: 7129).

Study Design: Patients were included in the study who operated on and followed up in our endocrinology and general surgery clinic with the diagnosis of multinodular and/or nodular goiter between September 2015 and April 2021. Among these patients, 724 individuals (456 females, 268 males) with complete detailed thyroid ultrasound scan reports, FNA cytology, and histopathology reports were included in the study. Patients with incomplete data were excluded. The demographic characteristics of the patients, preoperative thyroid ultrasound findings, FNA cytology reports, and histopathological analysis results were collected from the patient files and electronic records.

Data Collection: EU-TIRADS categories are evaluated in 5 main categories as EU-TIRADS 1: normal, EU-TIRADS 2: benign, EU-TIRADS 3: low risk, EU-TIRADS 4: intermediate risk and EU-

TIRADS 5: high risk (15). In our study, EU-TIRADS category 2, 3, 4 and 5 (TR 2, TR 3, TR 4 and TR 5), FNA reports and histopathologic distribution of thyroid cancers data were collected. FNA is performed through EU-TIRADS suggestions. The patients with follicular neoplasia, suspected malignancy, and positive malignancy findings in the FNA cytology report were operated on. Some patients with benign findings in the FNA cytology report presenting indications for aesthetic appearance and compression findings were also operated on. Benign and malignant rates of thyroid nodules were determined according to TIRADS classification, and the diffusion of the thyroid cancer was determined according to histopathology reports. Cases whose EU-TIRADS score was determined by criteria such as echogenicity, microlobulation, irregular edges, microcalcifications, pure cystic feature, spongy appearance, oval, or not in the preoperative thyroid US report made by an experienced endocrinologist were selected and included in the study.

In addition, intranodular rough calcifications, intermittent calcifications on the nodule wall, a nodule with intense blood supply, and solid nodules detected by Elastsonography are classified as TR-4 except four ultrasonographic characteristics which are highly suspicious for malignancy were classified as TR-4 (Figure 1).

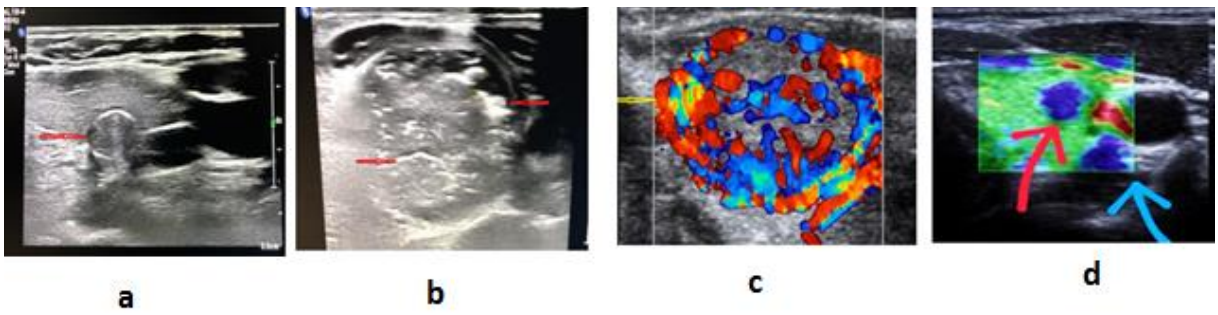

Figure 1. Intermittent calcifications in the thyroid nodule wall. **a**: coarse intranodal calcifications; **b**: intensely bloody nodule; **c**: and hard nodules on elastsonography; **d**: in TIRADS 4 categories.

The Ultrasound Scan (USS) reports of thyroid patients are recorded electronically in files of the endocrinology clinic of our hospital. Thyroid USS is performed in our endocrinology clinic during pre- and postoperative follow-ups in our hospital. Thyroid Ultrasonography was performed with high-resolution apparatus equipped with eL18-4 MHz broadband linear array probe (The Philips Affinity 70 ultrasound; Philips North America Corporation, 3000 Minuteman Road M/S 109 Andover, MA 01810, USA). All the procedures were performed by an experienced person.

Statistical Analyses: The SPSS 22.0 (SPSS, Inc., Chicago, IL, USA) was used for statistical analysis. Categorical variables were expressed as frequency and percentage values, continious variables as arithmetic mean and standard deviation. Statistical significance level was taken as $p<0.05$

Results

Of the 724 patients included in the study, 456 were female and 268 were male. The mean age of the patients was 48.15±11.7. Demographic data and thyroid function fold test parameter values of the patients are shown in Table 1.

Table 1. Demographic data and thyroid function fold test parameter values of the patients.

Parameters		**n/mean±standard deviation**
Gender	Female	456
	Male	268
Age (Years) SD		48.15±11.7
TSH, mIU/L		2.82±1.4
Anti-TPO, IU/mL		135.3±38.7
Anti-TG, IU/mL		91.5±13.7

TPOAb: Anti-thyroperoxidase autoantibodies; TgAb: Anti-thyroglobulin antibody.

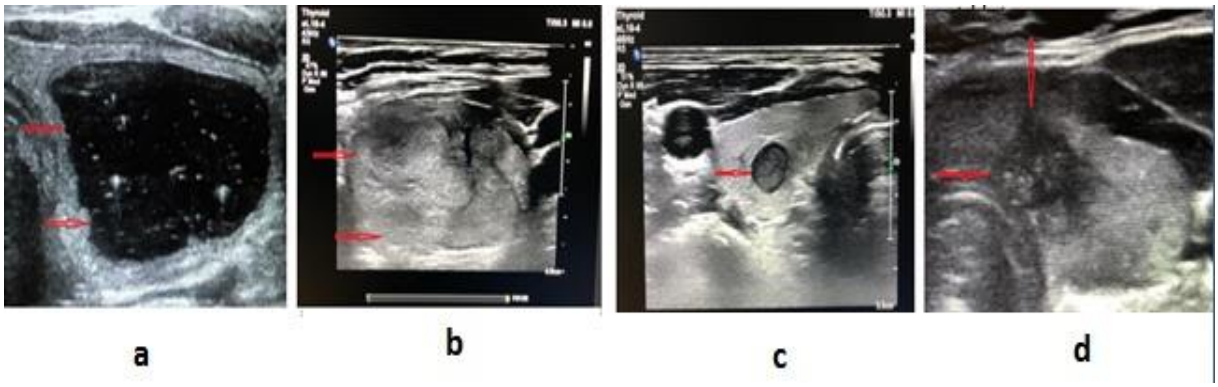

Figure 2. TIRADS categories and risk of malignancy.

TR-2, **a:** TR-3, ovoid, smooth, isoechoic or hyperechoic, no features of high suspicion, malignancy risk, 2-4%; **b:** TR-4, ovoid, smooth, mildly hypoechoic, no features of high suspicion, malignancy risk, ~6-17%; **c:** TR-5, at least 1 of the following features of high suspicion; **d:** Irregular shape, irregular margins, microcalcifications, marked hypoechogenicity (and solid), malignancy risk, 26-87%.

TIRADS categories and malignancy risk are shown in figure 2. Of 80 benign FNA patients, 20 (25.0%) were TR-2, 41 (51.2%) were TR-3, 14 (17.5%) were TR-4 and 5 (6.25%) were TR-5. Distribution of the cases according to TI-RADS Classification, FNA reports and histopathologic distribution of thyroid cancers were given Table 2. All of these patients were operated on within the scope of the indication. The FNA analysis result of 724 patients who have been operated on was as follows: benign by 11.04% (n=80), follicular, hurtle cell neoplasia or suspected hurtle cell neoplasia by 8.83% (n=64), suspected malignancy by 40.33% (n=292), malignancy by 39.77% (n=288).

The histopathological analysis results were nodular goiter, benign by 21.27% (n=154), malignancy by 77.9% (n=564), and lesion with unknown malignancy potential by 0.82% (n=6). Histopathological distribution of these cancers was papillary cancer at % 90.42 (n=510), follicular cancer at 7.44% (n=42), and medullary cancer at 2.12% (n=12) (Table 2). Intermittent calcifications in the thyroid nodule wall are shown in Figure 2. We detected the sensitivity and specificity of TIRADS classification as 100% and 67.5%, respectively. The positive and negative predictive values were 88.5% and 97%, respectively. These findings are shown in Table 3.

Table 2. Distribution of the cases according to TI-RADS Classification, FNA reports and histopathologic distribution of thyroid cancers.

Parameters	**TR-2 n (%)**	**TR-3 n (%)**	**TR-4 n (%)**	**TR-5 n (%)**
FNA benign, n=80	20 (100)	41 (97.6)	14 (4.4)	5 (1.4)
FNA follicular, Hurthle Cell neoplasia or suspicion, n=64	-	1 (2.3)	48 (15.1)	15 (4.3)
FNA malignity suspicion, n=292	-	-	153 (48.4)	139 (40.1)
FNA malignant, n=288	-	-	101 (31.9)	187 (5.4)
Histopathologically benign, n=154	20 (100)	**41 (97.6)**	85 (26.8)	8 (2.3)
Histopathologically malignant, n=564	-	-	228 (72.1)	336 (97.1)
Histopathological malignity potential unclear, n=6	-	1 (2.3)	3 (0.9)	2 (0.5)

FNA: Fine Needle Aspiration; TR: Thyroid Imaging Reporting and Data Systems (TIRADS).

Table 3. Diagnostic performances of TIRADS.

Parameter	Malignant	Benign	SE (%)	SP (%)	PPV (%)	NPV (%)
TIRADS 2-3	1	61	100	67.5	88.5	97
TIRADS 4-5	643	19				

TIRADS 2-3: According to the Thyroid Imaging Reporting and Data Systems category, not suspicious-mildly suspicious; TIRADS 4-3: According to the Thyroid Imaging Reporting and Data Systems category, moderately suspicious-highly suspicious; SE: Sensitivity; SP: Specificity; PPV: Positive predictive value; NPV: Negative predictive value.

Discussion

There are various guidelines recommended for the evaluation of thyroid nodules. Among these manuals, the risk factors determined by thyroid US in the evolution of thyroid nodules proposed by the Thyroid Association of America and British Thyroid Association and the revisions of these manuals are more common (7, 8). These guidelines focused on sonographic patterns rather than the size of the thyroid nodules as the primary determinant factor for biopsy. TIRADS classification predicts the malignant risks according to US characteristics of nodules. Complying with the risk classification system may result in a decreased number of unnecessary biopsies at significant levels (9, 10). Our study found that using TIRADS Scoring System increased the diagnostic performance of the thyroid nodules' evolution. Suppose cytologically non-diagnostic, atypical or follicular uncertainty is present in the nodules classified as TIRADS 1-3. In that case, the evolution of the nodule and/or cancer diagnosis may be inadequate because it is not operated on yet (11, 12). Our study showed that FNA increased the development of thyroid nodules through the reliability and diagnostic performance of ultrasonographic features. We determined that intranodular rough calcifications, intermittent calcifications on the nodule wall, the nodule with intense blood supply, and solid nodules detected by Elastsonography increase the risk of cancer from the other US features that are not classified in TIRADS. The risk of cancer was reported as ~0% in TIRADS 2 and 2-4% in TIRADS 3. In many previous studies, malignancy was not detected in any of the nodules with a score of TIRADS 1-3 (13, 14). We identified in our study that FNA biopsy was benign (20/20) in TI-RADS 2 nodules, FNA biopsy was benign in (41/42) FNA follicular, Hurthle cell neoplasia or suspected in 2.3% (1/42) in TI-RADS 3 nodules. Nodular goiter was detected in TIRADS 2, benign (20/20), nodular goiter in TIRADS 3, benign (41/42), and malignancy potential unclear in 2.3% (1/42) in postoperative tissue histopathology.

TIRADS classification system seems to have significant clinical value in determining benign and malignant thyroid nodules. Performing biopsy for nodules with high risk in line with TIRADS recommendations is considered as a rational approach.

It was shown that TIRADS 4 nodules have a 6-17% cancer risk (15). In other studies, cancer risk in TIRADS 4 nodules was 3.3-72.2% (6) and 5.9-12.8% (16). The cytology report result of TIRADS 4 nodules revealed the following result in our study: FNA benign by 4.43% (14/316), follicular, hurtle cell neoplasia or suspected hurtle cell neoplasia by 15.18% (48/316), suspected malignancy by 48.41% (153/316), and malignancy by 31.96% (101/316). Postoperative histopathological report results were as follows: nodular goiter, benign by 26.89% (85/316), thyroid cancer by 72.15% (228/316), lesion with unknown malignancy potential by 0.94% (3/316). When the present research was compared with the literature data, the cancer rate was much higher in TR-4 nodules. The inclusion of intranodular rough calcifications may explain such a higher rate, nodules with intense blood supply, solid nodules detected by elastsonography in TR-4 class along with highly suspected malignant lesion in EU-TIRADS (non-oval or round shape, irregular margins, microcalcifications, and a marked hypoechogenicity) and five ultrasound findings in ACR-TIRADS (composition, echogenicity, shape, margin, and echogenic foci). These US features appear to increase the risk of cancer. In this context, we think that these features should be included in the EU-TIRADS and ACR-TIRADS classification.

Cancer risk in TIRADS 5 nodules was 26-87% (5). This risk was reported to be 85.7% (18), 87.5% (7), 91% (19), and 100% in other studies (20). In our study, FNA biopsy benign was 1.44% (5/346) in TIRADS 5 nodules, FNA follicular, Hurthle cell neoplasia or suspicion was 4.33% (15/346), malignancy suspicion was 40.17% (139/346), and malignancy was 54.04% (187/346). In the postoperative tissue histopathology, we identified that nodular goiter was benign in TIRADS 5 at 1.73% (8/346), thyroid cancer at 97.10% (336/346), and malignancy potential unclear at 0.57% (2/346). In line with these findings, TIRADS 5 in our study was similar to the literature data in which thyroid nodules are at higher risk. TIRADS provides effective malignancy risk identification in the evolution of thyroid nodules. It appears to be beneficial in the decision of an FNA biopsy.

It is known that the prevalence of histological subtypes of thyroid tumors is 69.6% papillary thyroid carcinoma, 17.5% thyroid follicular carcinoma, 7.9% hurthle cell carcinoma, and 2.8% medullar thyroid

carcinoma (21). Papillary and follicular cancers constitute most thyroid cancers (>90%) (22, 23). In the present study, the histopathological distribution of thyroid cancers was found to be 89.47% papillary thyroid carcinoma, 7.36% thyroid follicular carcinoma, 2.1% medullary thyroid carcinoma, and 1.05% with uncertain malignancy potential. Our study results are similar to the frequency of differential thyroid and medullary cancers in line with the literature (21-23). In our study, the evaluation of thyroid nodules guided by the TIRADS classification presented a significantly higher sensitivity and moderate specificity, a higher negative predictive value to rule out malignancy, and a higher positive predictive value to detect malignancy.

Similar to EU-TIRADS, our findings showed that the risk of malignancy was associated with the composition, echogenicity, shape, marginal irregularities of the nodules, microlobulation, microcalcification, and echogenic foci. In addition, it was determined by the TR-4 classification that ultrasound features not included in EU-TIRADS increased the risk of thyroid cancer. In addition, there was no relationship between Anti-TPO, Anti-TG, TSH levels and malignancy.

Conclusion

In conclusion, in our study, the TIRADS scoring system successfully predicted the malignancy rate. In line with our findings, we support using the TIRADS scoring system for evaluating thyroid nodules, the risk of malignancy, and the classification of nodules. Since the risk of malignancy in TIRADS 2-3 thyroid nodules is very low, it can be followed in experienced clinics without a biopsy. Other ultrasound scan features (i.e., intranodular rough calcifications, nodules with intense blood supply, and solid nodules detected by elastosonography) were first evaluated within the TIRADS classification in our study. Clarified suggestions could be made for the approach to the nodules which are out of the classification as further studies support such findings. Biopsy must be performed for TIRADS 4 and 5 nodules. FNA biopsy must be performed in line with TIRADS Scoring System to avoid unnecessary biopsies until new methods are developed to detect cancer. These tumors are small and silent, and care must be paid to excessive biopsy recommendations for excessive diagnosis.

Conflict of Interest

No conflict of interest was declared by the authors.

Acknowledgement

All researches contributed equally to the study.

Ethics Committee Approval

This study was conducted by the ethical rules with the approval of Medicana International Samsun Hospital's clinical research ethics committee (Date: 20.04.2021, decision no: 7129,).

Author Contributions

Concept – ZE, HE, ÖKO; Supervision – ZE, HE, ÖKO; Materials – ZE, HE, ÖKO; Data Collection and/or Processing – ZE, HE, ÖKO; Analysis and/or Interpretation – ZE, HE, ÖKO; Writing – ZE, HE, ÖKO.

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