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# Evaluation of ultrasonographic thyroid imaging reporting and data system and color doppler imaging findings in thyroid nodules

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**Abstract**

The prevalence of thyroid nodules is high, and the most commonly used imaging modality is ultrasonography (US). Fine needle aspiration biopsy (FNAB) is performed for suspicious nodules after US evaluation, and a guideline called Thyroid Imaging Reporting and Data System (TIRADS) is available to make a biopsy decision. Our study aimed to evaluate TIRADS and Color Doppler Imaging (CDI) findings in nodules together with FNAB results. A total of 83 patients admitted to our hospital between January 2018 and January 2019 were included in this study retrospectively. B-mode US and CDI findings of the nodules, histopathological analysis results were recorded. Diagnostic efficacy of TIRADS classification and CDI findings were evaluated statistically. In our study, 70 (84.34%) of the nodules were found to be benign and 13 (15.66%) were found to be malignant. There was no difference between the benign and malignant groups in the evaluation of blood supply types using CDI ($p>0.05$). According to B mod US, 6 (27.3%) of 22 lesions with TIRADS 5, 5 (17.9%) of 28 lesions with TIRADS 4 and 2 (6.1%) of 33 lesions with TIRADS 3 were diagnosed as malignant. There was no statistically significant relationship between TIRADS categories and blood supply types in malignant lesions ($p> 0.05$). CDI examination of thyroid nodules did not reveal any blood supply patterns that could be significant for malignancy. CDI findings are not guiding to decide for FNAB.

**Keywords:** Doppler, thyroid nodule, TIRADS, ultrasonography

## Introduction

Thyroid nodules are common in the community, and these nodules are often benign [1]. TIRADS is a standardized method for determining the necessity of biopsy in thyroid nodules according to ultrasound images [2]. Thyroid malignancies are the most curable malignancies and early diagnosis is very important. FNAB is performed as the most valuable preoperatively method in determining the nature of thyroid nodules [3].

TIRADS was revised in 2017, and the scoring system is summarized in Table-1 [3]. There is no need for FNAB from nodules that score 0 and 2 according to TIRADS. Nodule with a score of three according to TIRADS, follow-up if larger than 1.5 cm, FNAB is required if greater than 2.5 cm. Nodule with a score of 4-6 according to TI_RADS, follow-up is necessary if it is greater than 1 cm and FNAB is required if it is greater than 1.5 cm. If the nodule score is seven or above according to TIRADS, a follow-up is required if diameter ≥ 0.5 cm and FNAB is required if ≥ 1 cm [4]. In TIRADS, the lesions are divided into five categories according to their score (Table 2). In TIRADS revised in 2017, CDI findings were not included in the scoring. CDI is used to determine the blood supply pattern in thyroid nodules. This study aimed to evaluate the patterns of CDI vascularization in the differentiation of benign and malignant in patients undergoing thyroid biopsy according to 2017 TIRADS.

## Materials and Methods

The study was approved by the Institutional Review Board and Ethics Committee and supported by the Institutional Research Fund. This is a retrospective study, which was conducted on 83 patients (71 females and 12 males) with thyroid nodules referred to FNAB between January 2018 and January 2019. images were reviewed from window settings. The mean age of our patients was 48 years (19-80). Patients under the age of 18, who had localized or systemic diseases that prevented biopsy, those who had previously been diagnosed with histopathology, who had inadequate material as a result of biopsy and who had a history of thyroidectomy were excluded from the study. Eighty-three patients had total of 83 nodules requiring biopsy. Nodules were examined simultaneously

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with B-mode US and CDI before the biopsy. All examinations were performed by the same radiologist, the same device (ToshibaAplio 500, Toshiba Medical System Co., Tokyo, Japan) and transducer (14MHz linear transducer). After demographic information of the patients was recorded, the patients were given the appropriate position according to the lesion location. The first B-mode US was performed, and the lesions were centralized. Lesion dimensions were measured perpendicular to the skin. The structure of each lesion (cystic/solid), echogenicity and shape (ovoid/spheric) of the lesion, edge characteristics, and whether or not it contained echogenic focus were evaluated. Considering these evaluations, the lesions were classified according to TIRADS. Afterward, blood flow patterns of nodules were evaluated by using CDI in the same position. Flow patterns were classified as 0) No blood, 1) Peripheral (Figure 1), 2) Intranodular, 3) Peripheral-Intranodular blood supply (Figure 2). After ultrasonographic and Doppler ultrasonographic examination was completed, US-guided fine needle biopsy was performed on the nodules. The biopsy was performed by using ten cc disposable syringes (21gaugex1.5 inch) and the materials were sent to pathology laboratory both as a direct smear and liquid-based smear (ThinPrep). Histopathological results of the materials were recorded.

**Statistical analysis**

For statistical analysis, SPSS 21.0 for Windows 7 (Statistical Package for the Social Sciences Inc.; Armonk, NY, USA) software program was used. Descriptive values of the data obtained in the study were given many patients, mean, standard deviation, maximum and minimum values. Independent Student-t-test was used to evaluate the differences between the means of independent groups and the ROC (Receiver Operating Characteristics) curve method was used to evaluate the performance of diagnostic tests. A value of $p<0.05$ was considered statistically significant.

**Results**

The mean age of 83 patients (12 males, 71 female) was 48 (19-80) years old. Histopathologic examination revealed 70 (84.34%) benign lesions and 13 (15.66%) malignant lesions. The mean age of the patients diagnosed as benign lesions was 45 years, and the mean age of the patients diagnosed as malignant lesions was 48 years. The mean of the largest diameters was 23.21 mm for all lesions, 17.15 mm for malignant lesions and 27.2 mm for benign lesions.

According to B mode US, 6 of 22 lesions evaluated as TIRADS 5 and 5 of 28 lesions evaluated as TIRADS 4 were diagnosed as malignant lesions histopathologically. Two of the 33 lesions evaluated as TIRADS 3 were diagnosed as malignant lesions histopathologically. Blood flow patterns in CDI of benign and malignant nodules are summarized in Table 3, blood flow patterns of benign nodules for TIRADS-3-4-5 are summarized in Table 4, and blood flow patterns of malignant nodules for TIRADS-3-4-5 are summarized in Table 5. There was no statistically significant difference between the benign and malignant groups in the evaluation of blood supply types performed by using CDI in the nodules ($p> 0.05$). Intranodular blood supply pattern was more common in malignant nodules. In our study, intranodular blood supply pattern was observed more in malignant nodules. In malignant lesions, type 0 blood supply rate was 15.4%, type 1 blood supply rate was 15.4%, type 2 rate was 53.84% and type 3 rate was 15.4%. In benign lesions, type 0 blood supply rate was 20%, type 1 blood supply rate was 35.71%, type 2 rate was 38.57% and type 3 rate was 5.71%. There was no statistically significant relationship between TIRADS categories and blood supply types in malignant lesions ($p> 0.05$). There was a statistically significant relationship between TIRADS categories and blood supply types in benign lesions ($p <0.05$). Most frequently type 1 and type 2 vascularization patterns are seen respectively benign lesions as evaluated TIRADS 3 and TIRADS 4-5.

**Table 1.** TIRADS 2017 scoring system is summarized.

| NODUL FEATURES | POINT |
|---|---|
| **STRUCTURE** | |
| Cystic / almost complete cystic | 0 |
| Spongy | 0 |
| Cystic-solid mixed | 1 |
| Solid or nearly solid | 2 |
| **ECHOGENICITY** | |
| Anechoic | 0 |
| Hyperechoic or isoechoic | 1 |
| Hypoechoic | 2 |
| Very hypoechoic | 3 |
| **SHAPE** | |
| ovoid | 0 |
| spheric | 3 |
| **EDGE FEATURES** | |
| Regular | 0 |
| Indefinite border | 0 |
| Lobulated or irregular | 2 |
| Extrathyroidal extension | 3 |
| **ECOGENIC FOCUS** | |
| No or large comet artifact | 0 |
| Macrocalcification | 1 |
| Peripheral (rim) calcification | 2 |
| Punctate echogenic focuses | 3 |

**Table 2.** TIRADS categories according to scoring

| SCORE | CATEGORIES |
|---|---|
| 0 | TI_RADS 1 |
| 2 | TI_RADS 2 |
| 3 | TI_RADS 3 |
| 4-6 | TI_RADS 4 |
| ≥ 7 | TI_RADS 5 |

**Table 3.** Blood flow patterns of benign and malignant nodules on CDUS

| | Benign | Malignant |
|---|---|---|
| **No blood supply (Type 0)** | 14 (20%) | 2 (15.4%) |
| **Peripheral blood supply (Type 1)** | 25 (35.71%) | 2 (15.4%) |
| **Intranodular blood supply (Type 2)** | 27 (38.57%) | 7 (53.84%) |
| **Peripheral-intranodular blood supply (Type 3)** | 4 (5.71%) | 2 (15.4%) |

**Table 4.** Distribution of blood supply patterns in benign lesions with TIRADS 3-4-5

| | TIRADS 3 | TIRADS 4 | TIRADS 5 |
|---|---|---|---|
| **No blood supply (Type 0)** | 4 | 5 | 5 |
| **Peripheral blood supply (Type 1)** | 14 | 11 | 0 |
| **Intranodular blood supply (Type 2)** | 4 | 13 | 10 |
| **Peripheral-intranodular blood supply (Type 3)** | 1 | 2 | 1 |

**Table 5.** Distribution of blood supply patterns in malignant lesions with TI-RADS 3-4-5

| | TIRADS 3 | TIRADS 4 | TIRADS 5 |
|---|---|---|---|
| **No blood supply (Type 0)** | 1 | 0 | 1 |
| **Peripheral blood supply (Type 1)** | 1 | 1 | 0 |
| **Intranodular blood supply (Type 2)** | 0 | 3 | 4 |
| **Peripheral-intranodular blood supply (Type 3)** | 0 | 1 | 1 |

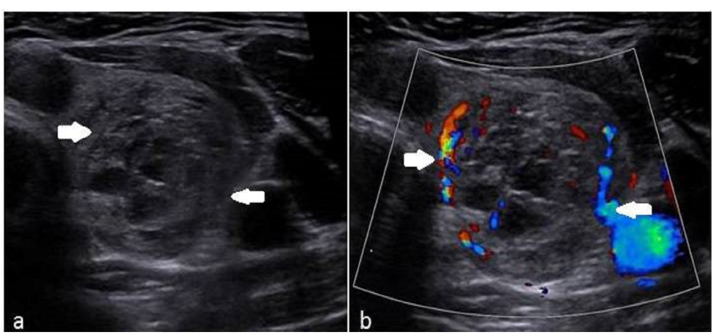


**Figure 1.** TIRADS 3 lesion(a) with peripheral blood supply on CDI (b)

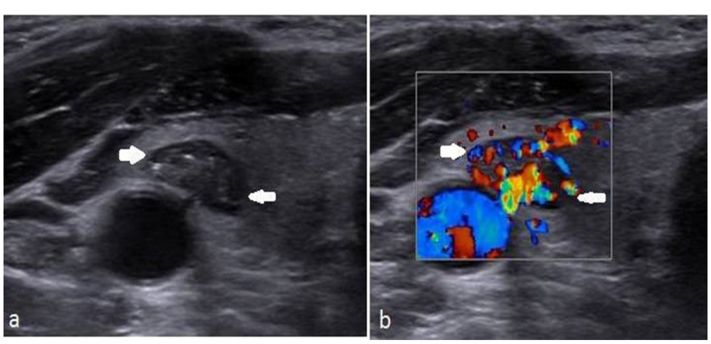


**Figure 2.** TIRADS 5 lesion(a) with peripheral-intranodal blood supply on CDI (b)

## Discussion

Since the widespread use of ultrasonography, the incidence of thyroid nodules has increased in asymptomatic patients [5]. Whether a fine needle aspiration biopsy is required for the detected thyroid nodules is evaluated by various classifications. The most common of these classifications is the thyroid imaging reporting and data system (TIRADS) 2017, which belongs to the American College of Radiology (ACR). According to TIRADS, nodules are scored according to structure, echogenicity, shape, edge characteristics, and echogenic focus. In TI-RADS 2017, scoring is performed according to grayscale findings only, and CDI, elastography and microvascular blood flow are not evaluated [4].

Phuttharak et al. and several studies showed that TIRADS had a higher interobserver agreement, a trend to have the highest sensitivity and negative predictive value for the diagnosis of malignant thyroid nodules [6-8]. However, Sahli et al., report low sensitivity for predicting malignancy and low specificity for predicting benign pathology to using the TIRADS classification [9]. It is also important to note that Cavallo et al. report an inverse relationship of size and malignancy risk, with 32% of nodules less than 1.0 cm in size found to be malignant [10]. However, there are several situations wherein TIRADS misdiagnosis of small malignancies [11].

In a meta-analysis study by Darvish et al., 288 research articles of CDI in thyroid nodules were evaluated and found that intranodular blood supply in CDI had a high predictive value in malignant lesions [12].

In the study of Phuttharak et al., The combination of B-mode US and CDI was reported to have high specificity and PPV [3]. In their study, blood flow patterns of nodules weren't evaluated by using CDI.

In the study of Moon et al., It has been reported that the use of combined B-mode US and CDI techniques may help to differentiate benign and malignant thyroid nodules. However, they reported that intranodular vascularity was more common in benign nodules [13].

In the study by Zhu et al., grayscale US and CDI findings were evaluated. The absence of vascularization in CDI was significant for benign nodules, whereas central vascularization was found to be significant for malignant lesions [14]. In their study, Yoon et al. found that elastography or CDI did not cause any increase in diagnostic performance that contributed to gray-scale US evaluation [15].

In our study, intranodular blood supply pattern was frequently detected in malignant nodules, but there was no statistically significant relationship between TIRADS categories and types of blood supply in malignant lesions. In benign lesions with TIRADS 4-5 most common type 2, blood supply pattern was observed, and in benign lesions, with TIRADS 3 patients most common type 1 blood supply was observed. Also, type 2 blood supply pattern was the most common pattern in malignant nodules.

## Conclusion

In conclusion, TIRADS and CDI examinations showed no significant relationship between thyroid nodule blood supply patterns and malignancy. Although the most common blood supply pattern in malignant lesions is type 2, this blood supply pattern is seen in benign lesions with TIRADS 4 -5. Therefore, we think that the blood supply pattern will not be effective when to decide for a biopsy.

**Competing interests**
*The authors declare that they have no competing interest.*

**Financial Disclosure**
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**Ethical approval**
*This retrospective study was approved by the Kutahya Health Sciences University Institutional Review Board and Ethics Committee (Project no: 2019/05) and supported by the Kutahya Health Sciences University Research Fund.*

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