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# Significance of Doppler Ultrasonography in Assessment of Thyroid Nodules

## Tiroid Nodüllerinin Değerlendirilmesinde Doppler Ultrasonografisinin Önemi

© Mehmet Celal Kızılkaya<sup>1</sup>, © Türkan İkizceli<sup>2</sup>

<sup>1</sup>University of Health Sciences Turkey, Kanuni Sultan Süleyman Training and Research Hospital, Clinic of General Surgery, İstanbul, Turkey

<sup>2</sup>University of Health Sciences Turkey, Haseki Training and Research Hospital, Clinic of Radiology, İstanbul, Turkey

### ABSTRACT

**Objective:** We aimed to compare Doppler ultrasonography (USG) findings and histopathological results after the operation on benign and malign thyroid nodules.

**Method:** A total of 122 patients applied to general surgery clinic because of thyroid nodule which were planned to operate has been analyzed prospectively. These patients have been included in the study with preoperative Doppler USG and fine-needle aspiration biopsy (FNAB) findings.

**Results:** Ninety five patients were female, and 27 were male. The mean age was 47.1 years. The mean size of nodules was 25.6 mm. Nodules had hypoechoic halo in 75 patients. Nodule vascularity increased in 81 patients. According to statistical analysis, there was a contrary relation between hypoechoic halo and malignancy ( $p = -0.285$ ). There was no relation between component and malignancy ( $p = -0.032$ ). We noted that malignancy was increasing with microcalcification. There was no relation between nodule margin and malignancy. It was observed that malignancy increased with vascularity.

**Conclusion:** With our study and information from the literature, in assessing thyroid nodules, examination of doppler USG is essential, and consideration with FNAB results makes preoperative diagnostic accuracy over 95%.

**Keywords:** Thyroid, nodule, ultrasonography, Doppler, histopathology, surgery

### ÖZ

**Amaç:** Benign ve malign tiroid nodüllerinde Doppler ultrasonografi (USG) değerlendirmesi ile elde edilen verileri operasyon sonrası piyes histopatoloji sonuçları ile karşılaştırmayı amaçladık.

**Yöntem:** Bir yıl içerisinde genel cerrahi kliniğinde tiroid nodülü nedeni ile operasyon planlanan 122 hasta prospektif olarak incelenmiştir. Tiroid nodülü nedeni ile operasyon planlanan 122 hasta operasyondan önce tiroid Doppler USG ve ince iğne aspirasyon biyopsisi (İİAB) değerlendirmeleri tamamlanarak çalışmaya dahil edilmiştir.

**Bulgular:** Çalışmaya alınan hastaların 95'i kadın, 27'si erkekti. Hastaların yaş ortalaması 47,1'di. Nodül büyüklüğü ortalama 25,6 mm idi. Yetmiş beş hastada nodül hipoeoik haloya sahipti. Seksen bir hastada nodül vaskülaritesi artmıştı. Yapılan istatistiksel değerlendirme sonucu hipoeoik halo ile malignite arasında ters bir ilişki olduğu görüldü ( $p = -0,285$ ). Komponentle malignite arasında ilişki saptanmadı ( $p = -0,032$ ). Mikrokalsifikasyonun arttıkça malignitenin arttığı görüldü. Nodül marjini ile malignite arasında ilişki saptanmadı ( $p > 0,05$ ). Vaskülarite arttıkça malignite arttığı gözlemlendi.

**Sonuç:** Yaptığımız çalışma ve literatür bilgisi ışığında tiroid nodüllerinin değerlendirmesinde Doppler USG incelemesinin aslında elzem olduğu ve bunun İİAB sonuçları ile birlikte değerlendirilmesi ile preoperatif tanı doğruluğunun %95 ve üzerine çıkarılabileceği aşikardır.

**Anahtar kelimeler:** Tiroid, nodül, ultrasonografi, Doppler, histopatoloji, cerrahi

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**Address for Correspondence/Yazışma Adresi:** Mehmet Celal Kızılkaya, University of Health Sciences Turkey, Kanuni Sultan Süleyman Training and Research Hospital, Clinic of General Surgery, İstanbul, Turkey

**E-mail:** drmcikizkaya@gmail.com **ORCID ID:** orcid.org/0000-0001-8314-9908

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## INTRODUCTION

Thyroid nodules are common clinical findings and were detected in approximately 50% of autopsies <sup>(1)</sup>. In addition, thyroid nodules are seen in 4-7% of patients due to clinical studies <sup>(2,3)</sup>. Because of the increased use of neck ultrasonography on patients worldwide, the rate of thyroid nodule detection has exceeded 67% <sup>(4)</sup>.

Approximately 67% of nodules are smaller than 15 mm <sup>(5)</sup>. Therefore, it has been suggested that thyroid nodules smaller than 15 mm are not malignant and do not require further evaluation. However, it has been shown that small nodules can be malignant, and thus further research is needed in light of recent studies <sup>(5,6)</sup>.

USG and FNAB have generally accepted procedures in the evaluation of thyroid nodules <sup>(7,8)</sup>. However, there are not enough studies on the diagnostic value of FNAB for small nodules <sup>(5)</sup>. FNAB is a standard practice in detecting thyroid cancer. It has decreased the number of thyroid surgeries and increased the rate of cancer diagnoses during thyroid surgery <sup>(9,10,11)</sup>. However, sometimes FNAB may result in unnecessary surgery <sup>(12)</sup>. To prevent this, FNAB and Doppler USG findings can be evaluated together.

It is not possible to make a definitive diagnosis of malignancy by USG. Some features detected by USG suggest nodule malignancy. However, these features can be observed in both benign and malignant nodules <sup>(5,13,14)</sup>. Characteristics such as echogenicity, nodule size, presence and type of calcification, and presence or absence of a hypoechoic halo help us distinguish between malignant and benign nodules. Many guidelines recommend FNAB for solid nodules larger than 10 mm and mixed echoic nodules larger than 15 mm <sup>(15,16)</sup>. Microcalcification is a specific marker of malignancy <sup>(15,16,17)</sup>, and intranodular and chaotic vascularity have been reported as ultrasound findings in suspected malignancies <sup>(16,17)</sup>.

This study compared the data obtained by Doppler USG evaluation of benign and malignant thyroid nodules with postoperative histopathologic results.

## METHOD

### Patient Selection

Patients scheduled for thyroid-nodule removal in the general surgery clinic within one year were prospectively examined. Approval was obtained from the ethics committee of Haseki Training and Research Hospital. In addition, informed consent was obtained from all patients. A total of 122 patients scheduled for thyroid-nodule removal were

included in the study after completing preoperative thyroid Doppler USG and FNAB. Patients scheduled for surgery due to recurrent thyroid nodules and hyperthyroidism were excluded. Doppler USGs of all patients were performed with the Hitachi EUB-7500 Hi-Vision ultrasound device (Hitachi Global, Tokyo, Japan) by a radiology specialist.

### Image Analysis

Thyroid nodules were first classified according to grayscale US findings. Intra-nodule vascularity was evaluated with power/color Doppler. The features of Doppler USG nodules were examined, and the nodules were divided into groups according to their margins, components, vascularity, and echogenicity and whether they contained microcalcifications or had hypoechoic haloes. The margins of the nodules were classified in the following ways: regular or irregular, with or without microcalcification, with or without hypoechoic haloes, solid or complex, whether vascularity was increased, and isoechoic or hypoechoic. The nodules were divided into 3 groups according to the RDUS findings: no obvious vascularity, presence of peripheral vascularity, and internal vascularity. According to Thyroid Imaging Reporting and Data System (TIRADS), the nodules were classified as 3-5.

By comparing the USG features of the groups of nodules with their FNAB (histopathology) results, we attempted to determine the relationship of the features revealed by USG to malignancy.

### Statistical Analysis

For statistical analyses Kolmogorov-Smirnov and regression tests were carried out using the Statistical Package for Social Sciences 15.0 (SPSS, Inc., Chicago, IL, USA) for Windows.

## RESULTS

In this study, 95 of the patients were female, and 27 were male. The mean age of the patients was  $45.10 \pm 11.88$  years (age range: 20-72 years). According to the final histopathology results, 82 of the nodules were benign, and 40 were malignant. The average nodule size was  $25.60 \pm 11.10$  mm, and the majority of the nodules had a regular margin and a solid component. In 75 patients, the nodule had a hypoechoic halo. Nodule vascularity was increased in 81 patients (Table 1).

Statistical analysis revealed an inverse relationship between hypoechoic haloes and malignancy ( $p = -0.285$ ). Malignancy decreases as hypoechoic halo increases. No relationship was found between components and malignancy ( $p = -0.032$ ). Malignancy was increased as microcalcification increase. No

relationship between nodule margin and malignancy ( $p > 0.05$ ) was observed (Table 2).

Malignancy was observed to increase with increased vascularity (Figure 1a, 1b). Therefore, RDUS findings, according to the type of vascularity, are given in Table 3.

As the TIRADS classification increased, malignancy rates increased when the nodules' features determined by Doppler USG were compared blindly with the FNAB results (Table 3).

## DISCUSSION

In previous studies, 3.6–9.9% of thyroid nodules were reported to be malignant <sup>(14,18-20)</sup>. In one study, sonographic data were not considered sufficient for distinguishing benign and malignant thyroid nodules, and FNAB was recommended in all cases <sup>(14)</sup>. In other studies, sonography could not distinguish benign and malignant nodules, and FNAB was

recommended in all cases <sup>(21,22)</sup>. However, in many studies, it has been stated that sonographic findings are useful for distinguishing benign and malignant nodules.

There is still uncertainty about which nodule properties are predictive of malignancy. One study suggested the presence of a single nodule, irregular borders, and microcalcification increased cancer risk 3.6, 5.4, and 39 times, respectively <sup>(23)</sup>. Taneri et al. <sup>(24)</sup> reported that the presence of multiple nodules is associated with malignancy, but Uğurlu et al. <sup>(23)</sup> found that single or double nodules increased the risk of malignancy.

Cappeli et al. <sup>(18)</sup> indicated a close relationship between solid and hypoechoic nodules with malignancy. However, in another study, hypoechogenicity was not associated with malignancy <sup>(25)</sup>. Undefined and irregular borders may increase the risk of solid and hypoechogenic nodule malignancy <sup>(5,25,26)</sup>. In our study, no relationship between nodule margins and malignancy was found ( $p > 0.05$ ).

One study showed that most malignant nodules have irregular borders and are hypoechogenic in appearance <sup>(21)</sup>. Moon et al. <sup>(27)</sup> reported that irregular borders were not associated with malignancy, but hypoechogenicity was found in the vast majority of malignant nodules; this study is consistent with the results of our study. In addition, many studies have found that nodule sizes 10 mm or greater are not necessarily benign <sup>(28)</sup>, and one study recommended FNAB evaluation of nodules larger than 5 mm <sup>(27)</sup>.

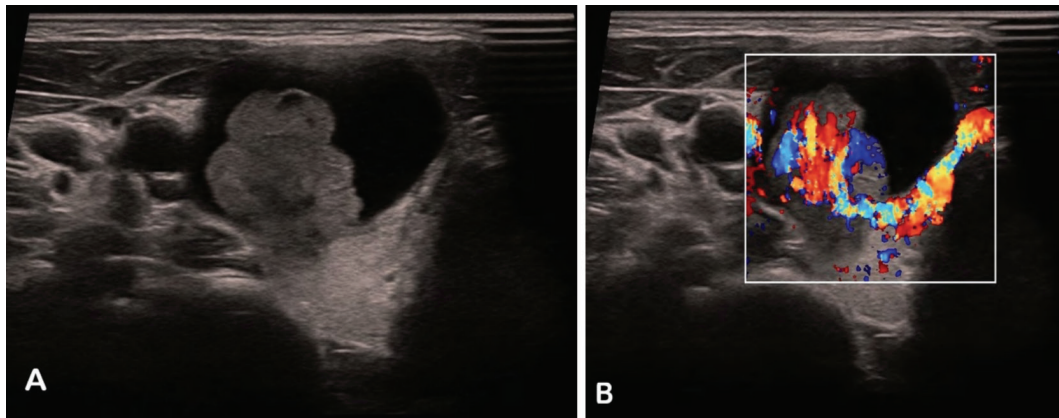
USG findings have been shown to complement FNAB for nodules with unknown follicular lesions or atypia. In this study, it was stated that when hypoechogenicity is longer than a nodule's width, USG can be very helpful for diagnosing malignancy <sup>(29)</sup>. Furthermore, if it is possible to perform nodule elastography during Doppler USG evaluation, the diagnosis accuracy of preoperative malignancy can be very high without requiring FNAB evaluation <sup>(30)</sup>.

Property	Value
Age (year) mean $\pm$ SD (min-max)	47.10 $\pm$ 11.88 (20-72)
Type n (%)	Female 95 (77.9)
	Male 27 (22.1)
Nodule size (mm) mean $\pm$ SD	25.60 $\pm$ 11.10
Nodule margin	Regular 95 (77.9)
	Irregular 27 (22.1)
Component	Solid 88 (72.1)
	Solid + cystic 34 (27.9)
Echogenicity	Isoechoic 71 (58.1)
	Hypoechoic 51 (41.9)
Hypoechoic halo	75 (61.4)
Calcification	No 54 (44.2)
	Yes 68 (55.8)
Vascularity	81 (67.4)

SD: Standard deviation, min: Minimum, max: Maximum

	Doppler USG				TIRADS		
	Benign (n/%)	Malignant (n/%)	Total (n/%)		Benign (n/%)	Malignant (n/%)	Total (n/%)
<b>No obvious vascularity</b>	32 (26.3)	7 (5.7)	39 (32.0)	<b>TIRADS 3</b>	31 (25.4)	7 (5.7)	38 (31.1)
<b>Peripheral vascularity</b>	17 (13.9)	14 (11.5)	31 (25.4)	<b>TIRADS 4</b>	44 (36.1)	10 (8.2)	54 (44.3)
<b>Internal vascularity</b>	33 (27.0)	19 (15.6)	52 (42.6)	<b>TIRADS 5</b>	7 (5.7)	23 (18.9)	30 (24.6)
<b>Total (n/%)</b>	82 (67.2)	40 (32.8)	<b>122 (100)</b>		82 (67.2)	40 (32.8)	<b>122 (100)</b>

USG: Ultrasonography, TIRADS: Thyroid Imaging Reporting and Data System



**Figure 1.** 27-year-old female patient. A) By grayscale ultrasound, there is a solid-cystic nodule with a regular margin in the right lobe. B) Doppler USG shows intense intranodular vascularity

USG: Ultrasonography

**Table 3. Doppler ultrasonography and TIRADS findings**

Sonographic feature	Statistical results (p)
Hypoechogenicity	< 0.05 (0.028)
Vascularity	< 0.05 (0.016)
Hypoechoic halo	< 0.05 (0.0014) r = -0.285
Microcalcifications	< 0.05 (0.0229)
Nodule margin (irregular border)	> 0.05 (0.322)
Component (solid-complex)	> 0.05 (0.724)

USG: Ultrasonography, TIRADS: Thyroid Imaging Reporting and Data System

### Study Limitations

Our study found that the increase in vascularity and hypoechogenicity and the presence of microcalcification were directly proportional to malignancy risk. Further, we observed that the risk of malignancy decreases with the presence of a hypoechoic halo. However, no significant relationship was found between nodule margins and their component and malignancy risk. The limitation of our study is that it does not include a wide range of nodule sizes. This is because we compared Doppler USG and histopathology results in patients who had decided to operate.

### CONCLUSION

Taken together with previous research, our results indicate that Doppler USG examination is essential in the evaluation of thyroid nodules and that the accuracy of preoperative diagnosis can be increased to 95% or more by combining Doppler USG with FNAB.

**Ethics Committee Approval:** Approval was obtained from the University of Health Sciences Turkey Haseki Training and Research Hospital Non-Drug Clinical Research Ethics Committee.

**Informed Consent:** In addition, informed consent was obtained from all patients.

**Conflict of Interest:** No conflict of interest was declared by the authors.

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