

# Retrospective Evaluation of Thyroid Nodules Detected During Carotid Doppler Ultrasonography

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## ABSTRACT

**Objective:** This study aimed to determine the prevalence and malignancy risk of incidental thyroid nodules detected during carotid Doppler ultrasonography in patients without a prior history of thyroid disease.

**Methods:** This retrospective study included 475 patients who underwent carotid Doppler ultrasonography between January and July 2025. Patients with known thyroid nodules or a history of thyroidectomy were excluded. Demographic data, thyroid findings, and American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS) scores were recorded from radiology reports, and cytology results were noted when fine-needle aspiration biopsy (FNAB) had been performed. Statistical analyses were performed using the Mann–Whitney U and Chi-square tests, with  $p < 0.05$  considered statistically significant.

**Results:** Thyroid nodules were incidentally detected in 272 of 475 patients (57.3%). The prevalence was 59.4% in females and 54.0% in males, with no significant sex difference ( $p = 0.28$ ). Patients with nodules were significantly older than those without ( $65.2 \pm 12.0$  vs  $61.4 \pm 13.6$  years,  $p = 0.003$ ). The mean maximum nodule diameter was  $10.5 \pm 8.1$  mm, and 30.1% of patients had nodules  $\leq 5$  mm. FNAB was performed in 15 patients; eight patients (2.9% of all 272 nodules) had cytology results that were malignant or suspicious for malignancy.

**Conclusion:** Incidental thyroid nodules are frequently detected during carotid Doppler ultrasonography. Most are benign, yet a small subset carries a risk of malignancy. Recognition and appropriate reporting of these findings are important for guiding further management and avoiding unnecessary interventions.

**Keywords:** carotid arteries, doppler, fine-needle, incidental findings, prevalence, thyroid nodule

## INTRODUCTION

Carotid Doppler ultrasonography is a widely used, non-invasive imaging modality that evaluates the extracranial carotid arteries for atherosclerotic disease and hemodynamic abnormalities [1]. Because of the close anatomical relationship between the carotid arteries and the thyroid gland, thyroid nodules can often be incidentally visualized during carotid Doppler ultrasonography examinations [2].

Thyroid nodules are a common clinical finding [3]. With the advancement of imaging technology, the detection rate of thyroid nodules has increased [2]. The prevalence of thyroid lesions incidentally detected during Doppler ultrasonography varies considerably among studies and is influenced by factors such as iodine supplementation status, patient age, and regional or population characteristics [3–9]. In a study conducted in Türkiye, Acar et al. reported a prevalence of 51.1% for thyroid nodules detected during carotid Doppler ultrasonography [2]. This finding highlights the relatively high frequency of such nodules in the Turkish population.

Despite the routine use of carotid Doppler ultrasonography in daily radiologic practice, studies focusing on incidental thyroid nodules detected during these examinations remain limited in Türkiye. To our knowledge, this study represents the largest cohort in the Turkish population evaluating the prevalence and ultrasonographic characteristics of thyroid nodules incidentally detected during carotid Doppler ultrasonography. The findings of this study are expected to contribute to a better understanding

of the epidemiology of incidental thyroid nodules in the Turkish population and to raise awareness about their clinical significance in routine carotid imaging practice.

## MATERIALS AND METHODS

This retrospective descriptive study was conducted at a tertiary radiology department after approval from the Ethics Committee of İzmir Katip Çelebi University (date: October 9, 2025, decision number: 0588). The Ethics Committee of İzmir Katip Çelebi University waived the requirement for informed consent because of the retrospective nature of the study. The study included consecutive patients who underwent carotid Doppler ultrasonography between January and July 2025.

Ultrasonography reports were retrospectively retrieved from the institutional Hospital Information Management System. All data were used solely for scientific purposes, and patient identifiers were removed to ensure anonymity. Reports were reviewed for thyroid-related findings, and data regarding the presence of thyroid nodules, the number of nodules, the American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS) scores of the most suspicious nodule, and the maximum diameter (in millimeters) of the largest nodule were recorded [10]. The records were also examined to determine whether fine-needle aspiration biopsy (FNAB) had been performed for any of the detected nodules, and cytology results were documented when available according to the Bethesda System for Reporting Thyroid Cytopathology [11]. Patient age and sex were also noted. In addition, carotid artery findings were categorized as normal, atherosclerosis, 50–69% stenosis, 70–99% stenosis, or occlusion [12].

Initially, a total of 647 patients who underwent carotid Doppler ultrasonography during the study period were identified. Patients with a previously known thyroid nodule ( $n = 129$ ) or a history of thyroidectomy ( $n = 43$ ) were excluded. Consequently, the final study population consisted of 475 patients.

All examinations were performed using a Samsung RS85 Prestige system (Samsung Medison Co., Ltd., Seoul, South Korea) equipped with a high-frequency LA2-14A linear transducer. Both carotid and thyroid assessments were performed by a single radiologist with eight years of experience in vascular and thyroid ultrasonography.

### Main Points

- Incidental thyroid nodules are frequently detected during carotid Doppler ultrasonography due to the close anatomical relationship between the carotid arteries and the thyroid gland.
- The prevalence of incidental thyroid nodules in this study was 57.3%.
- Fine-needle aspiration biopsy revealed malignant or suspicious cytology in 2.9% of all detected nodules, indicating that most nodules are benign.
- Recognition and appropriate reporting of incidental thyroid findings are essential for accurate risk assessment and to prevent unnecessary interventions.

**Statistical Analysis**

All statistical analyses were performed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) and categorical variables as number and percentage. The normality of continuous data was evaluated using the Shapiro–Wilk test. Comparisons of continuous variables between two independent groups were performed using the Mann–Whitney U test due to non-normal data distribution. Associations between categorical variables were analyzed using the Chi-square test. A p-value of less than 0.05 was considered statistically significant.

**RESULTS**

A total of 475 patients were included in the study. The mean age of the participants was 63.6 ± 12.8 years (range, 25–95 years), with a median age of 65 years (Q1–Q3: 55–73). Of these, 189 (39.8%) were male and 286 (60.2%) were female. The demographic and clinical characteristics of the study population are summarized in Table 1.

**Table 1.** Demographic and clinical characteristics of the study population

Variable	Value
Age	63.6 ± 12.8 (range, 25–95)
Sex	
Male	189 (39.8%)
Female	286 (60.2%)
Thyroid nodule presence	
Present	272 (57.3%)
Absent	203 (42.7%)
Carotid artery findings	
Normal	91 (19.2%)
Atherosclerosis	352 (74.1%)
50–69% stenosis	27 (5.7%)
70–99% stenosis	4 (0.8%)
Occlusion	1 (0.2%)

**Note:** Age is expressed as mean ± standard deviation, and all other variables are presented as number (percentage). For carotid artery findings, the more severe category was recorded in patients with asymmetric bilateral involvement. The category “Atherosclerosis” refers to the presence of plaques that do not result in hemodynamically significant stenosis (<50%).

The mean age was 63.7 ± 12.8 years in males and 63.4 ± 12.8 years in females. There was no statistically significant difference in age between the two groups (p = 0.82).

Among the 475 patients included in the study, thyroid nodules were incidentally detected in 272 (57.3%) cases. Thyroid nodules were detected in 59.4% of female (170/286) and 54.0% of male (102/189) patients, with no statistically significant difference between the two groups (p = 0.28). The mean age was 65.2 ± 12.0 years in patients with thyroid nodules and 61.4 ± 13.6 years in those without nodules. Patients with thyroid nodules were significantly older than those without nodules (p = 0.003) (Table 3).

**Table 2.** Distribution of thyroid nodules according to ACR TI-RADS categories

ACR TI-RADS category	Number of patients	Percentage (%)
TI-RADS 1	78	28.7
TI-RADS 2	44	16.2
TI-RADS 3	97	35.6
TI-RADS 4	44	16.2
TI-RADS 5	9	3.3
Total	<b>272</b>	<b>100.0</b>

**Note:** Data represent the highest ACR TI-RADS score per patient. ACR TI-RADS: American College of Radiology Thyroid Imaging Reporting and Data System.

**Table 3.** Comparison of demographic characteristics between patients with and without incidental thyroid nodules

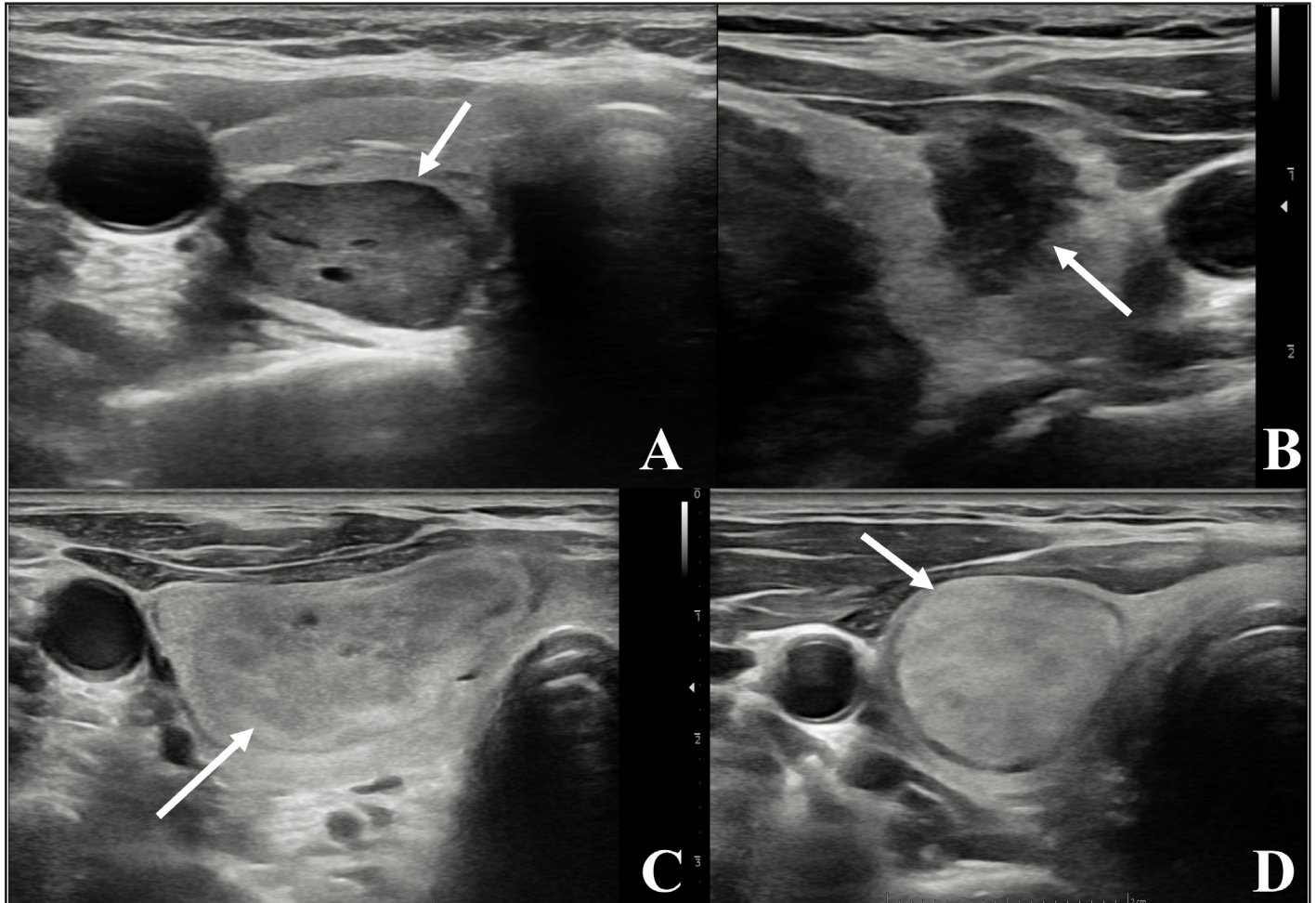
	With Nodules (n = 272)	Without Nodules (n = 203)	P
Female	170 (62.5%)	116 (57.1%)	0.278
Male	102 (37.5%)	87 (42.9%)	
Age	65.2 ± 12.0	61.4 ± 13.6	<b>0.003</b>

**Note:** Categorical variables (female and male) are presented as number (percentage). Age is expressed as mean ± standard deviation (years). **Bold** p-values indicate statistical significance (p < 0.05).

Among the 272 patients with incidentally detected thyroid nodules, the mean number of nodules per patient was 3.8 ± 3.2 (range, 1–15). The mean maximum diameter of the largest nodule was 10.5 ± 8.1 mm (range, 2–55 mm). Eighty-two patients (30.1%) had nodules measuring 5 mm or smaller in their largest dimension.

When considering the highest ACR TI-RADS score per patient, TI-RADS 3 (n = 97, 35.6%) was the most frequent category. The overall distribution of ACR TI-RADS categories is presented in Table 2. FNAB was performed in 15 patients. According to the 2023 Bethesda System for Reporting Thyroid Cytopathology

[11], cytological results were classified as follows: non-diagnostic in 3 (20.0%), benign in 4 (26.7%), atypia of undetermined significance in 4 (26.7%), follicular neoplasm in 1 (6.7%), and suspicious for malignancy in 2 (13.3%), and malignant (papillary thyroid carcinoma) in 1 (6.7%) case (Figure 1).



**Figure 1.** Representative examples of incidentally detected thyroid nodules during carotid Doppler ultrasonography. (A) In a 65-year-old female patient, an 18-mm predominantly solid and hypoechoic nodule (arrow) was incidentally identified in the right thyroid lobe during carotid Doppler ultrasonography. The lesion was classified as American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS) 4, and fine-needle aspiration biopsy (FNAB) revealed benign cytology. (B) In a 61-year-old female patient, an 11-mm markedly hypoechoic nodule with a taller-than-wide shape and lobulated-irregular margins (arrow) was incidentally detected in the left thyroid lobe. The nodule was classified as TI-RADS 5, and FNAB cytology was malignant (papillary thyroid carcinoma). The patient subsequently underwent surgery; histopathological results were not available in our records. (C) In a 52-year-old male patient, a 29-mm isoechoic solid nodule (arrow) was identified and categorized as TI-RADS 3. Cytological examination following FNAB confirmed benign features. (D) In a 59-year-old female patient, a 19-mm solid nodule that was iso- to mildly hyperechoic relative to the thyroid parenchyma (arrow) was incidentally detected and categorized as TI-RADS 3. The patient was referred to the endocrinology department for follow-up, and FNAB was not performed.

## DISCUSSION

In our study, incidental thyroid nodules were detected in 57.3% of patients who underwent carotid Doppler ultrasonography and had no prior history of thyroid nodules. Considering the close anatomical relationship between the thyroid gland and the carotid arteries, carotid Doppler ultrasonography may offer a valuable opportunity to identify clinically silent thyroid pathologies. This is particularly relevant during routine vascular examinations.

In the international literature, the reported prevalence of incidental thyroid abnormalities detected during carotid Doppler ultrasonography varies considerably across studies. In a study including 2,004 patients, thyroid abnormalities were identified in 9.4% of cases [13]. Another study involving 290 patients found incidental thyroid nodules in 19.6% of cases and suggested that this relatively high prevalence might be related to iodine deficiency in the studied population [6]. In patients without known thyroid disease, other ultrasound-based studies have reported incidental thyroid nodule rates ranging from 21% to 33% [5,14]. Similarly, in a cohort of patients undergoing carotid Doppler ultrasonography for cerebrovascular disease screening, the prevalence of incidental thyroid nodules was reported as 30.9% [15].

In Türkiye, Acar et al. reported a prevalence of 51% for thyroid nodules incidentally detected during carotid Doppler ultrasonography examinations, which was higher than most previous international series [2]. They attributed this difference to advances in ultrasound technology, the characteristics of the study population, and possibly regional iodine status.

In our study, the prevalence of incidentally detected thyroid nodules during carotid Doppler ultrasonography was 57.3%, slightly higher than both national and international data. Several factors may explain this finding. First, improvements in ultrasound resolution and sensitivity over time likely enhance the detection of small nodules. In our cohort, 30.1% of patients with thyroid nodules had lesions measuring 5 mm or smaller, which further supports the influence of advanced imaging technology on nodule detection rates. Second, regional epidemiologic variations, including iodine intake and genetic or environmental influences, may also contribute to the higher prevalence observed in our cohort. Lastly, our study population consisted of patients referred for carotid evaluation, many of whom presented with neurological symptoms or vascular risk factors. This group

is typically older. Therefore, the higher incidence of nodules observed in our cohort may partly be attributed to the older age profile of the study population. Indeed, age is a well-established determinant of thyroid nodule prevalence [6,16–18]. Consistent with previous reports, patients with thyroid nodules in our study were significantly older than those without nodules.

Thyroid nodules are classically reported to be more common in women [18–21]. A review has shown that the incidence of thyroid nodules in the general population is approximately four times higher in females than in males [22]. Similarly, Taheri et al. found incidental thyroid nodules in 57.1% of women and 46.5% of men in a cohort of 410 patients, and this difference was statistically significant [23]. However, not all studies have demonstrated female predominance. In certain subgroups, particularly in older populations, the sex difference tends to diminish. In the study by Acar et al., incidental thyroid nodules were detected at similar rates in both sexes, with no statistically significant difference [2].

In our study, incidental thyroid nodules were more frequently detected in female patients (59.4%) than in males (54.0%), but the difference was not statistically significant. The absence of a significant sex difference in our cohort may be related to the higher mean age of male participants. As the prevalence of thyroid nodules increases with age in both sexes [16–18], the female-to-male gap may narrow in elderly populations. Most large series have reported a higher prevalence of incidental thyroid nodules in women, although some studies and specific clinical subgroups have found comparable rates between sexes. Further research is needed to clarify the potential hormonal, genetic, and environmental factors underlying these differences. Previous studies have shown that the malignancy rate among incidentally detected thyroid nodules is generally low, averaging around 3% [13]. In the study by Rad et al., which evaluated 290 patients undergoing carotid Doppler ultrasonography, thyroid nodules were detected in 57 individuals, and FNAB was performed in 15 of them. Cytological examination revealed mostly benign lesions, while 3 cases showed cytopathologic findings consistent with malignancy or suspicious for malignancy [6]. Autopsy and ultrasound studies also indicate that less than 5% of asymptomatic nodules are malignant [24]. Consistent with these findings, in our study, FNAB was performed in 15 patients, and 8 of 272 nodules (2.9%) were cytologically malignant or suspicious for malignancy.

Overall, incidental thyroid nodules detected during carotid Doppler ultrasonography are a common finding. Although the vast majority are benign, a small subset carries a risk of malignancy. Therefore, incidental thyroid findings should not be disregarded. At the same time, the potential for unnecessary biopsies and patient anxiety must be considered. In routine clinical practice, patient management begins with the radiology report. When a radiologist identifies and documents an incidental thyroid nodule during carotid Doppler ultrasonography, this step initiates a clinical cascade (including further evaluation, endocrinology consultation, laboratory testing, follow-up ultrasonography, fine-needle aspiration biopsy, and possibly surgery). If the initial report lacks a standardized risk stratification (such as American Thyroid Association (ATA) classification or ACR TI-RADS), the referring physician may have difficulty assessing the nodule's risk and urgency [25,26]. This uncertainty can lead to either unnecessary concern and consultation or, conversely, the neglect of a clinically relevant lesion. Therefore, incidental thyroid nodules detected during carotid Doppler ultrasonography should be appropriately evaluated and reported in accordance with current guidelines to ensure balanced and effective patient management.

### Limitations

This study has several limitations. First, its retrospective design limited the control over data acquisition and variable standardization. Second, as a single-center study, the findings may not be fully generalizable to other populations. In addition, the 7-month study period represents a relatively short timeframe. Third, all examinations were performed by a single radiologist, which precluded assessment of interobserver variability. In addition, histopathological confirmation was available only for a limited number of nodules, and the analysis was restricted to the most suspicious lesion per patient according to the ACR TI-RADS system. Moreover, thyroid function tests and other clinical data were not evaluated, so the results reflect only sonographic characteristics. Nodule localization (right, left, or isthmus) was also not assessed, which limits the anatomical detail provided by the study. Finally, the study population consisted of patients referred for carotid Doppler ultrasonography, who are typically older and more likely to have comorbidities such as atherosclerosis. This referral pattern may introduce referral-related selection bias, and the observed prevalence of thyroid nodules may not represent that of the general healthy population. Despite these limitations, this study provides valuable insight

into the prevalence and ultrasonographic characteristics of incidentally detected thyroid nodules, supported by its relatively large cohort of patients undergoing carotid Doppler ultrasonography, contributing to the limited data on this subject. Future studies with larger, multicenter cohorts and prospective designs are needed to validate these findings and to better define the true prevalence and clinical significance of incidental thyroid nodules detected during carotid Doppler ultrasonography. Incorporating histopathologic confirmation, thyroid function assessment, and long-term follow-up data would further clarify the natural history and management implications of these lesions.

### CONCLUSION

Incidental thyroid nodules are frequently detected during carotid Doppler ultrasonography. Most of these nodules are benign, yet a small proportion carries a risk of malignancy. Recognition and appropriate reporting of these findings are important for guiding further management and avoiding unnecessary interventions.

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**Conflict of Interest:** The authors declare no conflict of interest.

**Informed Consent:** Informed consent was waived because of the retrospective design of the study.

**Data Availability Statement:** The datasets generated and/or analyzed during the current study are available from the corresponding author by reasonable request.

**Ethics Committee Statement:** This study was approved by the Health Research Ethics Committee of Izmir Katip Celebi University (Date: October 9, 2025; 2025-SAEK-0882, decision no: 0588).

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