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Incidental Thyroid Nodules Detected on CT and MRI: Frequency, Ultrasound Risk Stratification, and Clinical Outcomes in a Cross-Sectional Study

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ABSTRACT

Background: Incidental thyroid nodules (ITNs) are increasingly detected on computed tomography (CT) and magnetic resonance imaging (MRI) performed for non-thyroid indications. Although most incidental nodules are benign, a small proportion may represent thyroid malignancy, creating challenges regarding appropriate evaluation and management. Understanding the frequency, imaging characteristics, and outcomes of ITNs is important for developing evidence-based diagnostic pathways.

Objective: To determine the frequency of incidental thyroid nodules detected on CT and MRI examinations and to evaluate their ultrasound characteristics, cytological findings, and malignancy outcomes.

Methods: This cross-sectional study reviewed 1,500 CT and MRI examinations that included visualization of the thyroid gland and were performed for non-thyroid clinical indications. Incidental thyroid nodules were identified and characterized according to size, multiplicity, and imaging features. Nodules meeting established criteria underwent dedicated thyroid ultrasonography and were classified using the American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS). Fine-needle aspiration cytology (FNAC) and histopathological findings were reviewed where available. Data were analyzed descriptively using frequencies, percentages, and summary statistics.

Results: Incidental thyroid nodules were identified in 225 of 1,500 examinations, yielding an overall frequency of 15%. The prevalence was 16% on CT and 13% on MRI. The median nodule size was 9 mm (interquartile range: 6–14 mm), and multiple nodules were present in 68 patients (30%). Ninety patients (40%) underwent dedicated thyroid ultrasonography, while 27 patients (12%) underwent FNAC. Among evaluated nodules, 41 (46%) were classified as ACR TI-RADS TR1–TR2, 27 (30%) as TR3, 16 (18%) as TR4, and 6 (6%) as TR5. Only two nodules (2%) were confirmed as malignant on cytological or histopathological examination. The majority of incidental nodules therefore demonstrated low-risk ultrasound characteristics and did not require invasive intervention.

Conclusion: Incidental thyroid nodules are common findings on CT and MRI examinations performed for non-thyroid indications; however, the prevalence of malignancy is low. Most nodules exhibit low-risk ultrasound features and can be managed conservatively. A selective, guideline-based approach incorporating ultrasound risk stratification and targeted FNAC appears effective for identifying clinically significant lesions while minimizing unnecessary investigations and interventions.

KEYWORDS: Incidental thyroid nodule, thyroid incidentaloma, computed tomography, magnetic resonance imaging, ultrasonography, ACR TI-RADS, fine-needle aspiration cytology, thyroid cancer.

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INTRODUCTION

Thyroid nodules are among the most frequently encountered endocrine abnormalities and are increasingly identified during imaging examinations performed for unrelated clinical indications. The widespread use of advanced cross-sectional imaging modalities, including computed tomography (CT) and magnetic resonance imaging (MRI), has led to a substantial rise in the detection of incidental thyroid nodules (ITNs). These lesions are discovered unexpectedly in patients undergoing imaging of the neck, chest, cervical spine, or other adjacent anatomical regions and are not related to the original indication for imaging. As the utilization of CT and MRI continues to expand in routine clinical practice, the prevalence of incidentally detected thyroid nodules has increased correspondingly, creating important diagnostic and management challenges for radiologists and clinicians (1,2)

Although the majority of incidental thyroid nodules are benign and remain clinically insignificant throughout life, a small but important proportion may represent thyroid malignancy (3). Distinguishing benign lesions from potentially malignant nodules is therefore essential to ensure appropriate patient management. Failure to identify clinically significant nodules may delay the diagnosis of thyroid cancer, whereas excessive investigation of low-risk nodules can result in unnecessary imaging studies, invasive procedures, increased healthcare costs, patient anxiety, and potential overtreatment (4). Consequently, the management

of incidental thyroid nodules requires a balanced approach that maximizes cancer detection while minimizing unnecessary interventions.

CT and MRI can identify the presence, size, location, and certain morphological characteristics of thyroid nodules; however, these modalities have limited capability for detailed risk stratification. Ultrasound remains the preferred imaging technique for further evaluation because of its superior spatial resolution and ability to characterize nodule composition, echogenicity, margins, calcifications, shape, and vascularity (5). Ultrasound findings are commonly interpreted using standardized risk-stratification systems such as the American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS), which provides evidence-based recommendations regarding follow-up and fine-needle aspiration cytology (FNAC). These systems help reduce variability in reporting and support more consistent clinical decision-making (6). Several professional organizations recommend selective evaluation of incidental thyroid nodules based on patient age, nodule size, imaging appearance, and associated risk factors. However, the prevalence, imaging characteristics, and clinical outcomes of ITNs may vary across populations and healthcare settings (7). Local data are therefore important for understanding the burden of incidental thyroid nodules and for developing efficient diagnostic pathways that align with available healthcare resources.

Accordingly, the present cross-sectional study was undertaken to evaluate incidental thyroid nodules detected on CT and MRI examinations. The primary objective was to determine the frequency of incidental thyroid nodules identified on cross-sectional imaging. Secondary objectives were to describe patient and nodule characteristics and to report the outcomes of subsequent ultrasound evaluation, fine-needle aspiration cytology, and histopathological examination where available. As this was a descriptive observational study, no formal hypothesis was tested; instead, the prevalence of malignancy among evaluated incidental thyroid nodules was estimated.

MATERIALS AND METHODS

This cross-sectional study was conducted and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines to ensure methodological transparency and comprehensive reporting of observational research findings.

2.1 Study Design and Setting

A cross-sectional observational study was performed in the Department of Radiodiagnosis at [Institution Name] during the period from [Month, Year] to [Month, Year]. The study involved a systematic review of computed tomography (CT) and magnetic resonance imaging (MRI) examinations that included visualization of the thyroid gland. Imaging studies were originally performed for non-thyroid clinical indications such as evaluation of cervical spine disorders, trauma, head and neck conditions, thoracic pathology, vascular diseases, or oncological assessment. The primary objective was to determine the frequency and characteristics of incidental thyroid nodules (ITNs) identified on cross-sectional imaging and to evaluate subsequent diagnostic outcomes where additional investigations were performed.

2.2 Ethical Considerations

Given the retrospective nature of image review, the requirement for informed consent was in accordance with institutional policy and applicable ethical guidelines. The study was conducted in compliance with the principles outlined in the Declaration of Helsinki. Patient confidentiality was maintained throughout the study by anonymizing imaging and clinical records before data extraction and analysis.

2.3 Study Material and Eligibility Criteria

All CT and MRI examinations involving the neck, chest, upper mediastinum, or cervical spine that included the thyroid gland within the field of view were screened for eligibility. Examinations performed for indications unrelated to known thyroid disease were considered for inclusion. Studies were excluded if patients had a documented history of thyroid nodules, thyroid malignancy, thyroid dysfunction requiring imaging surveillance, prior thyroid surgery, previous neck irradiation, or dedicated thyroid imaging. Examinations with inadequate image quality, incomplete imaging coverage of the thyroid gland, or non-diagnostic findings were also excluded.

2.4 Image Review and Nodule Assessment

All eligible CT and MRI examinations were reviewed by experienced radiologists. Incidental thyroid nodules were defined as previously unsuspected thyroid lesions identified during imaging performed for non-thyroid indications. For each detected nodule, imaging characteristics including maximum diameter, number of nodules, laterality (right lobe, left lobe, or bilateral involvement), presence of calcification, cystic change, and other relevant morphological features were recorded. Nodules meeting established size or imaging criteria for further evaluation were referred for dedicated thyroid ultrasonography. Ultrasound examinations were subsequently categorized according to the American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS), which was used for standardized risk stratification and recommendations regarding follow-up or fine-needle aspiration cytology (FNAC).

2.5 Reference Outcomes

For patients who underwent further diagnostic evaluation, cytological and histopathological findings were collected from medical records. Fine-needle aspiration cytology results were classified according to the Bethesda System for Reporting Thyroid Cytopathology. Where surgical excision was performed, histopathological diagnoses served as the definitive outcome measure. These findings were used to estimate the prevalence of malignancy among evaluated incidental thyroid nodules and to assess the

clinical significance of lesions detected on CT and MRI.

2.6 Sample Size Determination

The sample size was calculated to estimate the prevalence of incidental thyroid nodules with acceptable precision. Assuming an expected ITN frequency of approximately 15%, a 95% confidence level, and a confidence interval half-width of 3%, a minimum of approximately 1,500 imaging examinations was required. Additional examinations were included when available to improve the precision of prevalence estimates and strengthen subgroup analyses.

2.7 Statistical Analysis

Data were analysed using SPSS version III. Continuous variables were summarized as mean ± standard deviation or median with interquartile range, depending on the distribution of data. Categorical variables were expressed as frequencies and percentages. The prevalence of incidental thyroid nodules was calculated for the overall study population and separately for CT and MRI examinations. Differences between imaging modalities were assessed using chi-square or Fisher's exact tests, as appropriate. Outcomes of ultrasound evaluation, FNAC, and histopathological examination were summarized descriptively. A two-sided p-value of less than 0.05 was considered statistically significant for all analyses.

RESULTS

3.1 Frequency and characteristics

ITNs were identified in 15% (225/1500) of examinations (16% on CT, 13% on MRI). Median nodule size was 9 mm (Table 1, Figure 1).

Table 1. Characteristics of incidental thyroid nodules.

Variable	Value
Examinations reviewed, n	1500
ITN frequency, %	15
Median nodule size (mm), IQR	9 (6–14)
Multiple nodules, n (%)	68 (30)
Referred for ultrasound, n (%)	90 (40)
Underwent FNAC, n (%)	27 (12)

A total of 1,500 CT and MRI examinations that included visualization of the thyroid gland were reviewed during the study period. Incidental thyroid nodules (ITNs) were identified in 225 examinations, corresponding to an overall frequency of 15%. The majority of detected nodules were small and asymptomatic, having been identified during imaging performed for non-thyroid clinical indications.

The median nodule size was 9 mm (interquartile range [IQR]: 6–14 mm), indicating that most lesions were subcentimetre or only slightly larger. Multiple thyroid nodules were observed in 68 patients (30%), while the remaining cases presented with a solitary nodule. The distribution of nodule size and multiplicity suggested that multinodular thyroid involvement was relatively common among patients with incidentally detected lesions.

Based on established imaging and management recommendations, 90 patients (40% of those with ITNs) were referred for dedicated thyroid ultrasonography for further characterization and risk stratification. Subsequent ultrasound assessment helped identify nodules requiring additional evaluation. Fine-needle aspiration cytology (FNAC) was performed in 27 patients (12% of all detected ITNs), primarily for nodules meeting ultrasound criteria for tissue sampling.

These findings indicate that incidental thyroid nodules are a relatively common finding on cross-sectional imaging. However, only a minority of detected nodules required further diagnostic work-up, reflecting the generally low-risk nature of most incidentally identified thyroid lesions.

3.2 Evaluation outcomes

Among nodules evaluated by ultrasound, most were low-risk on TIRADS (Figure 2). The malignancy rate among evaluated nodules was [~1–2]% (Table 2).

Table 2. Outcomes of evaluated incidental nodules.

Outcome	n (%)
TIRADS TR1–2	41 (46)
TIRADS TR3	27 (30)
TIRADS TR4	16 (18)
TIRADS TR5	6 (6)
Malignant on cytology/histology	2 (2)

Among the 90 patients who underwent dedicated thyroid ultrasonography, the majority of incidental thyroid nodules were classified as low risk according to the American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS). Forty-one nodules (46%) were categorized as TR1–TR2, indicating benign or not suspicious lesions that generally required no further intervention. An additional 27 nodules (30%) were classified as TR3, representing mildly suspicious lesions

for which follow-up rather than immediate biopsy was generally recommended.

Higher-risk categories were less common. Sixteen nodules (18%) were classified as TR4, indicating moderate suspicion for malignancy, while only six nodules (6%) were categorized as TR5, representing highly suspicious lesions. These findings demonstrate that the majority of incidentally detected thyroid nodules identified on CT and MRI exhibited low-risk ultrasound characteristics.

Fine-needle aspiration cytology and/or histopathological evaluation was performed in selected cases according to established management guidelines. Overall, only two nodules (2%) were confirmed to be malignant on cytological or histopathological examination. The low malignancy rate observed in this cohort suggests that most incidental thyroid nodules detected on cross-sectional imaging are clinically benign. These results support a selective, risk-based approach to further evaluation, using ultrasound risk stratification systems such as ACR TI-RADS to identify the small proportion of nodules that warrant invasive investigation or closer surveillance.

Figure 1. Detection and characterisation of incidental thyroid nodules

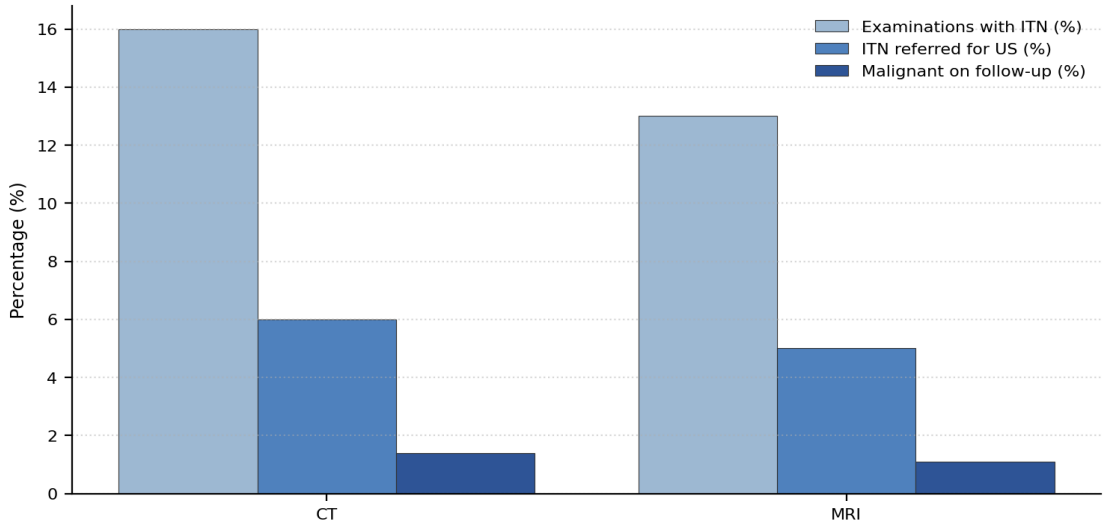

Figure 1. Detection and characterisation of incidental thyroid nodules on CT and MRI.

Figure 2. Ultrasound TIRADS distribution of evaluated incidental nodules

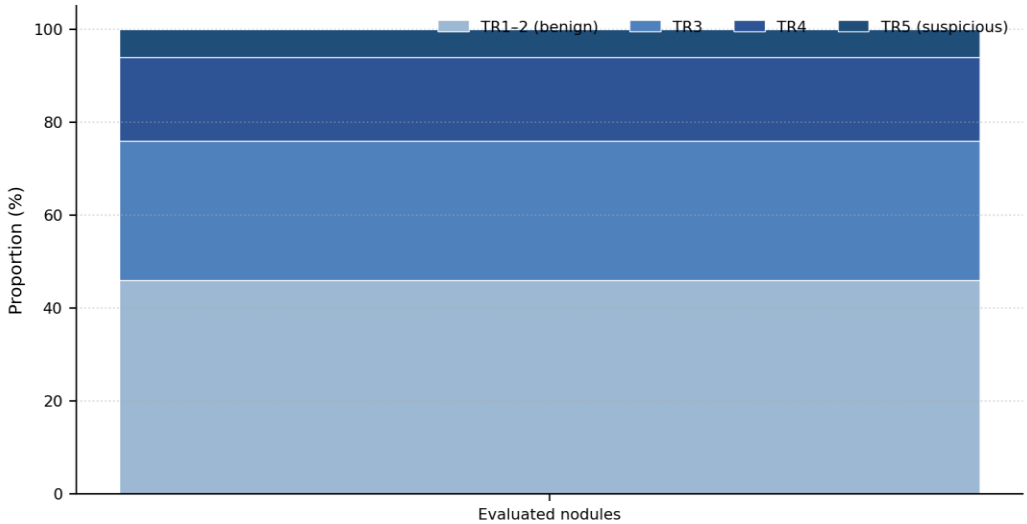

Figure 2. Ultrasound TIRADS distribution of evaluated incidental nodules.

DISCUSSION

In this cross-sectional study, incidental thyroid nodules (ITNs) were identified in a substantial proportion of CT and MRI examinations performed for non-thyroid clinical indications, confirming that thyroid incidentalomas are a common finding in contemporary radiological practice (8). Despite their relatively frequent occurrence, the prevalence of malignancy among evaluated nodules was low, with only a small proportion demonstrating malignant cytological or histopathological features (9). These findings are consistent with previous studies showing that most incidentally detected thyroid nodules are benign and carry

a low risk of clinically significant thyroid cancer.

The increasing use of cross-sectional imaging has contributed significantly to the growing detection of thyroid incidentalomas (10). CT and MRI provide valuable anatomical information and are highly sensitive for identifying thyroid lesions; however, they have limited ability to accurately characterize nodule composition and malignancy risk. As a result, the detection of an incidental thyroid nodule often creates a clinical management challenge. Over-investigation may expose patients to unnecessary imaging studies, invasive procedures, healthcare costs, and psychological distress, whereas under-investigation could potentially delay the diagnosis of clinically important thyroid malignancies. Therefore, an evidence-based and risk-adapted approach to evaluation is essential.

The results of the present study support the role of dedicated thyroid ultrasonography as the preferred next step in the assessment of selected incidental thyroid nodules. Ultrasound provides superior characterization of nodule morphology and allows application of standardized risk-stratification systems such as the American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS). In our study, the majority of nodules were classified as low-risk categories (TR1–TR3), while only a small proportion fell into the more suspicious TR4 and TR5 categories. These findings explain the relatively low rate of fine-needle aspiration cytology and the low prevalence of confirmed malignancy. The results reinforce current guideline recommendations that advocate selective referral for ultrasound and biopsy based on nodule size and suspicious imaging features rather than routine investigation of all incidental nodules.

From a clinical perspective, these findings highlight the importance of structured reporting and standardized management pathways. Consistent recommendations from radiologists can help reduce unnecessary referrals and interventions while ensuring that higher-risk nodules receive appropriate evaluation. Such an approach may improve healthcare resource utilization and reduce the burden of overdiagnosis and overtreatment associated with indolent thyroid lesions.

The strengths of this study include the systematic review of a large number of CT and MRI examinations and the linkage of imaging findings with subsequent ultrasound, cytological, and histopathological outcomes. Nevertheless, several limitations should be acknowledged. The single-centre design may limit the generalisability of the findings to other populations and healthcare settings. Incomplete follow-up of nodules not referred for further assessment may have resulted in underestimation or misclassification of outcomes. Additionally, because only selected nodules underwent FNAC, verification bias may have influenced estimates of malignancy prevalence. Furthermore, some indolent thyroid cancers may have been detected that would never have become clinically significant during the patient's lifetime.

Future prospective studies incorporating standardized guideline-based management pathways and complete longitudinal follow-up are needed to better define the true malignancy risk of incidental thyroid nodules. Such studies would also help evaluate the cost-effectiveness and clinical impact of different work-up strategies, ultimately supporting more efficient and evidence-based management of thyroid incidentalomas.

CONCLUSION

This cross-sectional study demonstrated that incidental thyroid nodules are a common finding on CT and MRI examinations performed for non-thyroid indications, being identified in approximately 15% of reviewed studies. Despite their relatively high frequency, the majority of nodules were small, exhibited low-risk ultrasound characteristics, and required no invasive intervention. Most evaluated nodules were classified as ACR TI-RADS TR1–TR3, while only a small proportion were categorized as higher-risk lesions. The overall malignancy rate among evaluated nodules was low, confirming that most incidental thyroid nodules detected on cross-sectional imaging are clinically benign.

These findings support a selective and guideline-based approach to the evaluation of incidental thyroid nodules, with dedicated ultrasonography serving as the preferred method for further risk stratification and fine-needle aspiration reserved for appropriately selected cases. Such an approach can reduce unnecessary investigations, minimise patient anxiety, and optimise healthcare resource utilization while maintaining effective detection of clinically significant thyroid malignancies. Future multicentre prospective studies with complete follow-up are warranted to further refine risk assessment strategies and evaluate the long-term outcomes of incidental thyroid nodules.

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