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Intrathyroidal ectopic thymus in childhood: ultrasound features for accurate diagnosis

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ABSTRACT

Aims: To characterize the ultrasonographic features of intrathyroidal ectopic thymus (IET) in pediatric patients and emphasize the role of ultrasound (US) in its accurate identification to prevent misdiagnosis.

Methods: Eighty-four pediatric patients (aged 3–12 years) were referred for neck US due to cervical lymphadenopathy, during which incidental lesions in the thyroid gland were detected. These lesions, identified within normal thyroid parenchyma, were classified as IET. In such cases, color Doppler US (CDUS) was also performed without additional cost or workload..

Results: Among 84 pediatric patients, all IET lesions appeared as solid nodules with smooth margins and no mass effect. Ten lesions were uniformly hypoechoic, while 74 showed scattered internal bright echoes. Lesions measured 4–12 mm and were predominantly fusiform (59.5%), followed by triangular and round shapes. IET was unilateral in most cases (88%), with a marked left-lobe predominance, and all lesions were localized to the mid-to-lower thyroid lobe. CDUS demonstrated reduced or normal vascularity without suspicious flow patterns. Follow-up imaging in 62 children showed stable findings, with gradual size reduction in 8 adolescents and complete regression in one child. Echogenicity (p=0.001), lesion shape (p=0.01), and location (p=0.03) were significantly associated with IET characteristics, supporting their diagnostic relevance.

Conclusion: The presence of internal echogenicities and mid-to-lower lobe localization, especially in the left lobe, are key diagnostic indicators. IET is more prevalent than previously recognized. Recognition of its US features may prevent unnecessary interventions. Routine US monitoring is recommended, while further diagnostic procedures are generally unwarranted.

Keywords: Intrathyroidal ectopic thymus, thyroid gland, thyroid nodule, thyroid ultrasonography

INTRODUCTION

The thymus is a bilobed organ situated in the anterior superior mediastinum, superior to the heart and posterior to the sternum, with essential roles in immune regulation and endocrine function. Embryologically, it primarily originates from the third pharyngeal pouch, with minor contributions from the fourth pouch, developing between the fifth and sixth weeks of gestation. The thymus comprises tissues derived from all three embryonic germ layers. Around the eighth week, bilateral thymic primordia fuse at the midline and migrate caudomedially to their definitive location. Incomplete migration or arrested development can result in residual thymic tissue along this pathway. Given their adjacent embryologic origins-specifically the third pharyngeal pouch and thyroid diverticulum-the migration patterns of the thymus and thyroid are closely linked. Cervical thymic remnants are often underrecognized due to their asymptomatic nature and incidental discovery during surgical procedures.[1,2]

Ultrasound (US) is widely used for thyroid evaluation in pediatric patients, capable of detecting minor anomalies even in asymptomatic individuals.[2] Although thyroid nodules are rare in children, they carry a higher malignant potential compared to those in adults.[3-5] Ectopic thymic tissue can sonographically mimic a thyroid nodule, often presenting as a hyperechoic lesion that may raise suspicion of malignancy.[6-8] It is therefore essential to recognize the distinct sonographic features of ectopic thymic tissue in order to differentiate it from potentially malignant nodules and thus avoid unnecessary fine-needle aspiration biopsies.[9-11]

The main purpose of this article is to draw attention to the ultrasonographic detection of this intrathyroidal ectopic thymus (IET) lesion, especially in the pediatric age population, without the need for interventional procedures.

METHODS

Ethics

This retrospective study was approved by the Non-interventional Ethics Committee of Gaziosmanpaşa Training and Research Hospital with specific attention to the inclusion of vulnerable participants (e.g., children, pregnant women, individuals with disabilities) (Date: 28.05.2025, Decision No: 65). Additional safeguards were reviewed and approved by the committee. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Study Design

This retrospective study was conducted in the US Unit of the Radiology Department at Gaziosmanpaşa Training and Research Hospital (İstanbul) and included pediatric patients who underwent ultrasonographic examinations between August 2019 and October 2025. Among those referred for neck US due to cervical lymphadenopathy, cases with incidentally detected thyroid lesions suggestive of ectopic thymus-initially described in the reports as possible IET-were identified through a comprehensive review of archived US reports. Only cases with adequate image quality and optimal visualization were included in the study.

Lesions identified from the reports were further evaluated on corresponding US images. Sonographically, these lesions were located within otherwise normal-appearing thyroid parenchyma and exhibited finely granular (speckled or hyperechoic) internal echotexture with delicate linear echogenic strands, resembling normal thymic tissue. None of the cases demonstrated suspicious sonographic features indicative of malignancy, such as irregular margins, marked or heterogeneous hypoechogenicity, increased intralesional vascularity on color Doppler US (CDUS), or mass effect. The consistency between sonographic reports and imaging findings was thereby confirmed.

Population

Over the six-year study period, a total of 84 pediatric patients (46 boys and 38 girls) aged between 3 and 12 years were included. All patients had available follow-up ultrasonography records at 6, 12, and 18 months. Only those with normal thyroid function test results were enrolled. Patients with a known thyroid disorder, a history of thyroid surgery, palpable thyroid nodules, abnormal or unavailable thyroid function test results, or a history of radiation exposure to the head and neck region were excluded from the study.

Ultrasound Examination and Image Interpretation

All examinations were performed in the US unit of the radiology department using high-resolution linear transducers (5–10 MHz and 10–14 MHz) on Toshiba Aplio 300 or Siemens Acuson S300 systems. All studies were conducted and interpreted by a single experienced radiologist, ensuring technical and interpretive consistency across the cohort.

Operational Diagnostic Criteria for IET

To ensure diagnostic consistency and reproducibility, lesions were classified as IET when they demonstrated a constellation of characteristic sonographic and clinical features derived from established descriptions of thymic tissue in pediatric imaging literature. Specifically, IET was identified when a lesion was located in the mid-to-lower portion of a thyroid lobe and exhibited a finely granular or speckled internal echotexture with delicate linear echogenic strands, closely resembling the classic “starry-sky” appearance of normal thymic parenchyma. The margins were smooth and well defined, without distortion or displacement of adjacent thyroid tissue, and no suspicious features suggestive of malignancy-such as irregular borders, marked hypoechogenicity, microcalcifications, or extrathyroidal extension-were present. CDUS showed either decreased or normal vascularity compared with the surrounding thyroid parenchyma, with no focal intralesional hypervascularity. Clinically, lesions were non-palpable, asymptomatic, and detected in children with normal thyroid function. In a subset of patients, the diagnosis was further strengthened by the presence of direct anatomical continuity between the intrathyroidal lesion and an elongated cervical or mediastinal thymus. The final diagnosis of IET was established by integrating these imaging features with longitudinal sonographic stability during follow-up.

Follow-Up

US follow-up at 6, 12, and 18 months was available for 62 children. Lesions were assessed for changes in size, echogenicity, margins, and vascularity. Regression or stability was recorded as part of the natural evolution of thymic tissue.

Statistical Analysis

Data analyses were performed to examine distribution patterns and internal variability among IET lesions. Three clinically meaningful subgroup categories were predefined within the cohort: echogenicity (hypoechoic lesions vs. lesions containing bright internal echoes), lesion shape (fusiform vs. non-fusiform, the latter including round and triangular configurations), and lobe involvement (right, left, or bilateral). Continuous variables such as lesion size were assessed for normality using the Shapiro-Wilk test. Depending on distribution characteristics, normally distributed variables were compared using the Student’s t-test, whereas non-normally distributed variables were analyzed with the Mann-Whitney U test. Categorical variables-including echogenicity patterns, shape classifications, lobe involvement, and vascularity-were compared using the Pearson Chi-square test or Fisher’s exact test when expected cell counts were small. A two-sided p-value <0.05 was considered statistically significant. All analyses were conducted using IBM SPSS Statistics (Version 25.0). Importantly, because the aim of the study was to characterize internal features of IET rather than compare IET to non-IET nodules or estimate prevalence, all statistical tests were restricted to comparisons within the IET cohort, and no diagnostic accuracy assessments or prevalence calculations were performed.

RESULTS

A total of 84 children met the inclusion criteria, all demonstrating an intrathyroidal lesion with smooth margins, absence of mass effect, and benign sonographic morphology. Lesion size ranged from 4 to 12 mm, with a mean±SD of 8.2±2.4 mm. Most lesions exhibited bright internal echoes

(74/84, 88.1%) (**Figure 1**), whereas a smaller subset appeared hypoechoic (10/84, 11.9%) (Figure 2). In terms of shape, the majority were fusiform (50/84, 59.5%), followed by triangular (18/84, 21.4%) and round configurations (16/84, 19.1%). Lesions predominantly involved the left thyroid lobe (50/84, 59.5%), with fewer located in the right lobe (24/84, 28.6%) or bilaterally (10/84, 11.9%). Color Doppler ultrasonography demonstrated decreased vascularity in 40 children (47.6%) and vascularity similar to surrounding thyroid tissue in 44 (52.4%) (**Figure 2**). In 16 children (19.0%), the intrathyroidal lesion showed direct anatomical continuity with an elongated cervical thymus, providing strong supportive evidence for the diagnosis of IET. These descriptive ultrasonographic features are summarized in **Table 1**.

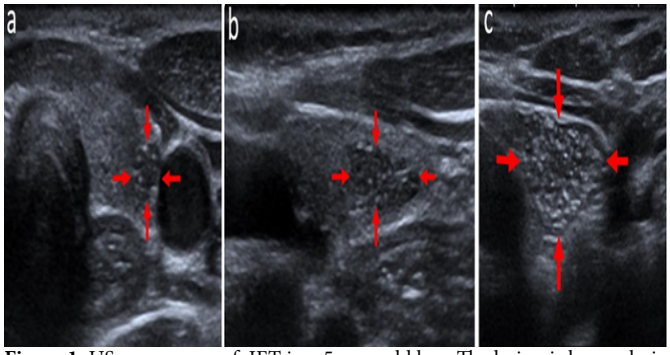

Figure 1. US appearance of IET in a 5-year-old boy. The lesion is hypoechoic compared with the surrounding thyroid parenchyma and contains punctate echogenic foci, showing a characteristic ultrasonographic similarity to normal thymic tissue (marked with red arrows).

(a) Axial image demonstrating the lesion lateral to the left thyroid lobe. (b) Longitudinal image showing the lesion near the inferior aspect of the left thyroid lobe. (c) US image of normal thymic tissue. (IET: Intrathyroidal ectopic thymus, US: Ultrasound)

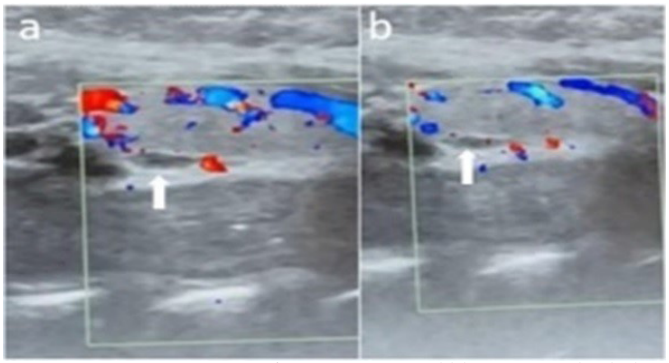

Figure 2. CDUS appearance of IET in a 6-year-old boy. Longitudinal plane ultrasound images of a patient with an incidental IET located in the posterior region of the left thyroid lobe (marked with white arrows)

CDUS evaluation at two separate time points (a, b) demonstrates vascularity comparable to the surrounding thyroid parenchyma. (CDUS: Color Doppler ultrasound; IET: Intrathyroidal ectopic thymus, US: Ultrasound)

Subgroup analyses revealed several notable internal distribution patterns. When echogenicity was considered, lesion size did not differ significantly between hypoechoic lesions (mean 7.6±2.1 mm) and those with bright internal echoes (mean 8.3±2.4 mm; p>0.05). However, lesions with bright internal echoes were significantly more likely to be located in the left lobe (46/74, 62%) compared with hypoechoic lesions (4/10, 40%), indicating a non-random distribution (p<0.05). Vascularity did not differ between these groups (p>0.05). Detailed comparisons between echogenicity subgroups are presented in **Table 2**.

In the analysis of lesion shape, fusiform lesions demonstrated a slightly larger mean size (8.4±2.3 mm) compared with non-fusiform lesions (7.9±2.5 mm), although this difference was not statistically significant (p>0.05). Bright internal echoes were significantly more common in fusiform lesions (47/50, 94%) than in non-fusiform lesions (27/34, 79%) (p<0.05). Furthermore, fusiform lesions exhibited a stronger left-lobe predominance (35/50, 70%), again supporting a non-uniform lobe distribution pattern (p<0.05). These shape-based subgroup comparisons are shown in **Table 3**.

When lobe involvement was evaluated independently, lesions located in the left lobe demonstrated the highest prevalence of bright internal echoes (46/50, 92%), followed by bilateral lesions (10/10, 100%) and right-lobe lesions (18/24, 75%), yielding a statistically significant overall difference (p=0.03). Lesion size did not differ significantly among the right, left, and bilateral groups (p>0.05). While fusiform morphology appeared more common in left-lobe lesions (33/50, 66%) compared with right-lobe lesions (12/24, 50%) or bilateral involvement (5/10, 50%), this trend did not reach statistical significance (p>0.05). Lobe-based subgroup analyses are

Table 1. Descriptive characteristics of IET lesions (n = 84)

Characteristic	Value
Lesion size, mm (mean±SD, range)	8.2±2.4 (4-12)
Echogenicity	
Bright internal echoes	74 (88.1%)
Hypoechoic	10 (11.9%)
Shape	
Fusiform	50 (59.5%)
Triangular	18 (21.4%)
Round	16 (19.1%)
Lobe involvement	
Left lobe	50 (59.5%)
Right lobe	24 (28.6%)
Bilateral	10 (11.9%)
CDUS	
Decreased	40 (47.6%)
Similar to parenchyma	44 (52.4%)
Continuity with cervical thymus	16 (19.0%)

CDUS: Color Doppler ultrasound, IET: Intrathyroidal ectopic thymus, SD: Standard deviation

Table 2. Comparison according to echogenicity subgroups

Parameter	Hypoechoic (n=10)	Bright internal echoes (n=74)	p-value
Lesion size, mm (mean±SD)	7.6±2.1	8.3±2.4	>0.05
Left lobe involvement	4 (40%)	46 (62%)	<0.05
Decreased vascularity	6 (60%)	34 (46%)	>0.05

*Statistically significant at p<0.05, SD: Standard deviation

Table 3. Comparison according to lesion shape

Parameter	Fusiform (n=50)	Non-fusiform (n=34)	p-value
Lesion size, mm (mean±SD)	8.4±2.3	7.9±2.5	>0.05
Bright internal echoes	47 (94%)	27 (79%)	<0.05
Left lobe involvement	35 (70%)	15 (44%)	<0.05

*Statistically significant at p<0.05, SD: Standard deviation

summarized in Table 4. Collectively, these findings indicate that bright internal echoes and fusiform morphology are the dominant sonographic phenotypes of IET and that left-lobe localization is disproportionately represented across these patterns.

Table 4. Comparison according to lobe involvement

Parameter	Right (n=24)	Left (n=50)	Bilateral (n=10)	p-value
Bright internal echoes	18 (75%)	46 (92%)	10 (100%)	0.03
Lesion size, mm (mean±SD)	Similar across groups	Similar across groups	Similar	>0.05
Fusiform morphology	12 (50%)	33 (66%)	5 (50%)	>0.05

*Statistically significant at p<0.05, SD: Standard deviation

Follow-up ultrasonography was available in 62 children. During longitudinal assessment, the vast majority of lesions (53/62, 85.5%) remained morphologically stable, while 8 children (12.9%) demonstrated gradual reduction in lesion size. Complete resolution occurred in a single 6-year-old girl, with disappearance of the lesion documented 18 months after initial identification. Importantly, none of the lesions developed suspicious sonographic features over time, and no child required biopsy or surgical intervention. These follow-up findings reinforce the benign nature of IET and underscore the safety of conservative sonographic surveillance in typical cases.

DISCUSSION

IET is an uncommon but clinically relevant entity in pediatric thyroid imaging, primarily because of its potential to mimic thyroid nodules and thereby prompt unnecessary invasive procedures. The present study provides a comprehensive ultrasonographic characterization of IET in a relatively large pediatric cohort and reinforces the role of high-resolution US as a reliable, noninvasive tool for its identification and follow-up.

Thyroid nodules are rare in children but carry a substantially higher malignancy risk compared with adults, reported to range between 22% and 26%.[4,12] Consequently, any intrathyroidal lesion detected on US in the pediatric population often raises concern and leads to further diagnostic workup. In this context, ectopic thymic tissue represents a well-recognized diagnostic pitfall. Several previous reports have described IET being misinterpreted as suspicious thyroid nodules, resulting in fine-needle aspiration or surgical excision for definitive diagnosis.[7,8,14,15] Our findings support the growing body of evidence that careful assessment of sonographic morphology can reliably distinguish IET from true thyroid nodules, thereby avoiding unnecessary interventions.

Embryologically, the thymus originates primarily from the third pharyngeal pouch and descends caudally toward the mediastinum during early fetal development. Given the close developmental relationship and migration pathways of the thymus and thyroid, remnants of thymic tissue may persist along this route and become embedded within or adjacent to the thyroid gland.[7,10,16] This embryologic background explains the characteristic mid-to-lower lobe localization observed in our cohort and reported consistently in prior studies.[9,17,19]

In the present series, IET lesions demonstrated a highly consistent ultrasonographic appearance: smooth margins, absence of mass effect, and a finely granular or "starry sky" echotexture with punctate or linear echogenic foci corresponding to thymic septa and Hassall's corpuscles.[10,17] These features closely mirrored the appearance of the normally positioned cervical or mediastinal thymus, and in nearly one-fifth of cases, direct anatomical continuity between the intrathyroidal lesion and an elongated thymus was observed. This continuity provides particularly strong imaging evidence for the diagnosis of IET and has been emphasized as a key confirmatory feature in the literature.[19]

Color Doppler ultrasonography in our cohort demonstrated either decreased vascularity or vascularity comparable to the surrounding thyroid parenchyma, with no suspicious flow patterns. While Segni et al.[19] reported an absence of detectable vascularity in their series,other studies have similarly described reduced or normal vascularity rather than hypervascular patterns.[9,17] These findings suggest that Doppler characteristics should be interpreted as supportive rather than decisive features and always considered in conjunction with grayscale morphology.

Importantly, although certain sonographic features-such as fusiform shape, bright internal echoes, and left-lobe predominance-were frequently observed in our cohort, these characteristics should not be interpreted as standalone diagnostic criteria. Rather, they represent common phenotypic patterns within IET lesions. Their diagnostic value lies in their combined presence alongside typical location, benign morphology, lack of mass effect, and clinical context, rather than in isolation. This distinction is essential to avoid overinterpretation of descriptive findings as definitive diagnostic indicators.

Longitudinal follow-up further supported the benign nature of IET. Most lesions remained stable over an 18-month period, while a subset demonstrated gradual size reduction, consistent with physiological thymic involution during late childhood and adolescence. Complete regression, although uncommon, was documented in one patient. These observations align with previous longitudinal studies and reinforce conservative US surveillance as an appropriate management strategy for typical IET lesions.[19]

The present study does not aim to estimate the prevalence of IET in the general pediatric population or among all children undergoing neck US. Rather, it characterizes the imaging features of lesions already identified as IET within a specific referral population. In this context, our findings suggest that IET may be encountered more frequently in routine pediatric neck US practice than is often appreciated, particularly when careful attention is paid to thymus-like echotexture and typical localization. However, any inference regarding prevalence should be made cautiously and within the limitations of the study design.

Overall, the principal contribution of this study lies in its relatively large sample size, systematic documentation of sonographic features, demonstration of internal distribution patterns within IET lesions, and confirmation of benign behavior on follow-up. Together, these findings provide practical guidance for radiologists and pediatric clinicians and support a noninvasive, observation-based approach in typical cases.

Limitations

This study has several limitations that should be acknowledged. First, its retrospective design introduces inherent selection bias. The study population consisted exclusively of children referred for neck US due to cervical lymphadenopathy, rather than a general pediatric or thyroid-specific screening population. As a result, the findings may not be fully generalizable to other clinical settings or referral indications.

Second, no histopathological confirmation was available, as the diagnosis of IET was based on characteristic ultrasonographic features and longitudinal stability or regression. While this may be considered a limitation, it also reflects real-world clinical practice and aligns with current recommendations to avoid invasive procedures in lesions with a clearly benign imaging profile. The presence of direct continuity with cervical thymus in a subset of cases further strengthens the imaging-based diagnosis.

Third, although subgroup analyses were performed to explore internal distribution patterns within the IET cohort, the study did not include a non-IET control group. Therefore, the findings should be interpreted as descriptive rather than diagnostic accuracy or comparative results.

Finally, the follow-up period, while sufficient to demonstrate stability or regression in most cases, may not capture very long-term evolution of all lesions. Longer follow-up studies could further clarify the natural history of IET across different pediatric age groups.

CONCLUSION

IET is a benign developmental variant that can closely mimic thyroid nodules in children. Recognition of its characteristic ultrasonographic features-particularly thymus-like echotexture with internal echogenicities, smooth margins, absence of mass effect, and typical mid-to-lower lobe localization-allows confident, noninvasive diagnosis in most cases. Although certain features such as fusiform shape and left-lobe predominance are commonly observed, they should be regarded as supportive rather than definitive diagnostic markers.

In children with non-palpable, asymptomatic intrathyroidal lesions and normal thyroid function, typical sonographic findings consistent with IET warrant conservative management with US follow-up rather than immediate biopsy or surgery. Awareness of this entity and its imaging characteristics is essential to prevent unnecessary invasive procedures and to promote appropriate, patient-centered care in pediatric thyroid imaging.

ETHICAL DECLARATIONS

Ethics Committee Approval

This retrospective study was approved by the Non-interventional Ethics Committee of Gaziosmanpaşa Training and Research Hospital with specific attention to the inclusion of vulnerable participants (e.g., children, pregnant women, individuals with disabilities) (Date: 28.05.2025, Decision No: 65). Additional safeguards were reviewed and approved by the committee.

Informed Consent

As this was a retrospective study, formal written informed consent was not required and was therefore not obtained.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

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Author Contributions

Concept: K.L.; Design: K.L.; Control: K.L.; Resources: D.T.; Materials: D.T.; Data Collection and/or Processing: K.L., D.T., Ö.T.N.; Analysis and/or Interpretation: K.L.; Ö.T.N.; Literature Review: D.T., Ö.T.N.; Writing The Article: Ö.T.N.; Critical Review: D.T., Ö.T.N., K.A.

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