The Turkish Journal of Pediatrics 2017; 59: 387-394
DOI: 10.24953/turkjped.2017.04.004 *Original*

Ectopic intrathyroidal thymus in children: Prevalence, imaging findings and evolution

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Received: 28th December 2016, Accepted: 5th May 2017

SUMMARY: Erol OB, Şahin D, Bayramoğlu Z, Yılmaz R, Akpınar YE, Ünal ÖF, Yekeler E. Ectopic intrathyroidal thymus in children: Prevalence, imaging findings and evolution. Turk J Pediatr 2017; 59: 387-394.

The aim of this study was to evaluate the ultrasound (US) features of intrathyroidal ectopic thymus (IET) and demonstrate the alterations after follow-up.

This study included 36 lesions of 32 patients (mean age 95 ± 58 months) diagnosed with IET. The patients underwent follow-up US examination at least 22-months without a medication or surgical intervention.

A total of 36 IETs with an incidence of 0.91% were detected among 3914 thyroid ultrasound (US) examinations. The mean of anteroposterior (ap), transverse (tr), and craniocaudal (cc) diameters in the initial US examinations were 3.1±1.19 mm, 4.89±1.86 mm, and 6.45±3.92 mm respectively. All of the lesions were well-demarcated, hypoechoic to the thyroid gland, and contained uniformly distributed punctate echogenic foci. Follow-up US examinations were performed after 684±85 days. The alterations between the initial and follow-up diameters for ap and cc direction were not statistically significant. However, a significant difference (p=0.007) was found for transverse diameters and the IETs were found to be smaller at follow-up US than in the initial US. Most of the IETs were located in the left lobe (64%), middle portion (83%), and extended to a border of thyroid gland (69%) and nonspherical in shape (89%).

The descriptive findings of IETs are uniform distribution of punctate echogenic foci, absence of a rim, and the presence of vessels traversing through the lesion without parenchymal displacement. Given our findings, healthcare professionals should be aware of the diagnosis of IET. Patients with an IET could be safely managed with follow-up US and any surgical treatment would not be required.

***Key words:** ectopic, thymus, thyroid, ultrasound, Doppler, children.*

The extension of the thymus to the inferior border of the thyroid gland is frequently observed in routine neck ultrasound (US) examinations, especially during the inspiratory phase. The separation of the cervical ectopic thymus from the mediastinal thymus is a well-known condition in clinical practice, though not as familiar as the aberrant extension of the mediastinal thymus to the neck.[1] Embryologically, the thymus migrates from the mandibular angle down to the superior mediastinum, the defects of which may cause the thymus to become ectopically located, either partly or totally, as seen mostly in the cervical region.[2] Focal lesions of the thyroid gland in children detected by US are mostly benign, rarely malignant thyroid nodules, though focal thyroiditis can be mistaken for thyroid nodules.[3,4] In our study, we depicted thyroid lesions resembling the above mentioned lesions and suggesting thymic tissue due to identical features observed with US. Intrathyroidal ectopic thymus (IET) is rarer than ectopic cervical thymus but more common than believed and frequently detected incidentally on neck US. Since further awareness of this condition can negate the need for unnecessary biopsy or surgical removal,[5,6] we aimed to reveal the US and Doppler US features of IET with a case series involving the most living subjects reported to date in order to demonstrate any alteration in size at follow-up.

Materials and Methods

We performed 3,914 thyroid US examinations in our radiology department from June 2012 to July 2015. Our sample included 32 patients diagnosed with IET due to characteristic sonographic features. Patients were referred for an US neck examination to investigate a thyroid nodule (n = 9, 28%), cervical lymphadenopathy (n = 17, 53%), or biopsy decision for a thyroid lesion depicted in another hospital (n = 6, 18%). The patients underwent US control using a 14 MHz high-resolution linear transducer on a high-end US scanner (Logiq 9, General Electric Healthcare Medical Systems) without fine-needle aspiration biopsy or surgical removal. All patients also underwent a thymus US examination at the same time to compare the echotexture of the thyroid lesion with the patient's own thymus gland. In some cases, we could not perform a US control because of the patient's incompatibility and for some cases we performed thyroid US many times. The data included the patient's age, gender, the initial diameters in anteroposterior, transverse, craniocaudal dimensions, the echogenicity, shape, border, number, and location of the lesions. Gray-scale and color-power Doppler US images, and video records, were retrospectively evaluated by the consensus of radiologists having more than three years pediatric neck US practice. An ectopic thymus exceeding one border of the thyroid gland and having a connection with extrathyroidal ectopic thymus or mediastinal thymus was excluded from this study. This study was approved by the local ethic committee after informed consent was obtained from the patient's parents.

Results

Sixteen male patients with a mean age of 99 ± 64 months and, 16 female patients with a mean age of 91.5± 54.6 months (in general 95.16 ± 58.29 months) were evaluated. The mean anteroposterior (ap), transverse (tr), and craniocaudal (cc) diameters of IET at initial diagnosis were 3.1±1.19 mm, 4.89 ± 1.86, and 6.45 ± 3.92 mm, respectively (Table I).

Nine (25%) lesions in the right (Fig. 1a), and 21 (58%) lesions in the left lobe (Fig. 1b) of the thyroid gland were found (Table II). Two patients (6%) with IET in both thyroid lobes, and 2 patients (6%) with left-sided lesions were seen (Fig. 1). A total of 36 IET cases were found in 32 patients.

Four IET (11%) cases in the medial portion, 11 IET (30%) in the lateral portion, and 19 IET (52%) in the middle portion of the thyroid gland were seen via axial plane US (Fig. 2a, 2b). Four IET lesions (11%) were located in the upper pole, 2 lesions (5%) in the lower pole, and 30 lesions (83%) in the middle portion of the thyroid gland: each was depicted on the longitudinal plane via US views. Twenty-five lesions (69%) extended to the thyroid gland border: 8 were posterior, 7 were medial, and 10 had lateral margins (Fig. 3a, 3b). Extension to an anterior margin was not seen in any case. Cervical ectopic thymus without a connection to the IET or mediastinal thymus was detected in 4 patients (11%) as an accompanying finding (Fig. 4a, 4b).

Four (11%) IET had a spherical shape (Fig. 5a), while 32 (89%) IET had a non-spherical shape (Fig. 5b). The echo patterns of the IET were identical to the mediastinal thymus we had examined. All lesions were well-demarcated, and contained uniformly distributed linear or punctate echogenic foci (Fig. 6a, 6b, 6c). Thirty-five lesions were hypoechoic to the thyroid gland. A lesion obtained in a 15-years old child was hyperechoic to the thyroid gland while it is isoechoic with his mediastinal thymus (Fig. 7a, 7b). None of the lesions revealed peripheral halo or rim vascularity on color power Doppler US examination, suggesting a true nodule. No vascularity was depicted within the 21 lesions (58%), while 15 lesions (42%) demonstrated one or more non-displaced vascular structure(s) traversing through the lesion (Fig. 8a, 8b, 8c).

A total of 27 lesions underwent US control after 684±85 days. The ap and craniocaudal and transverse diameters of the lesions were measured in each follow-up imaging (Fig. 9a, 9b). We detected no statistically significant differences between the previous and control diameters for ap direction ($p=0.8$). However, significant differences were detected when comparing the previous and control transverse diameters; the IETs were smaller than at the

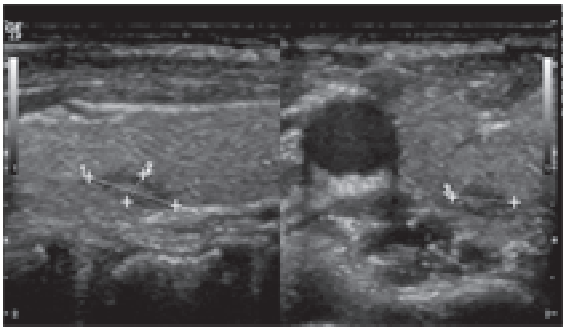
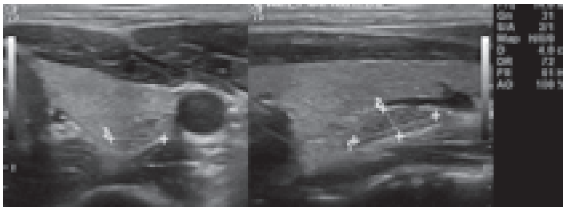


Fig. 1. Hypoechoic righ sided IET on Fig. **1a.** and left sided IET on Fig. **1b** with nonspherical shape are seen.



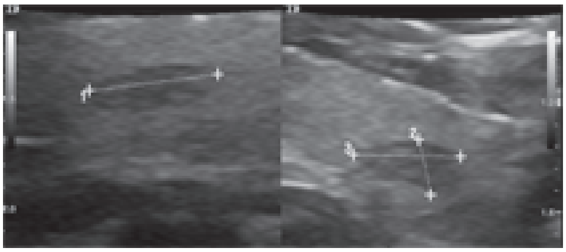
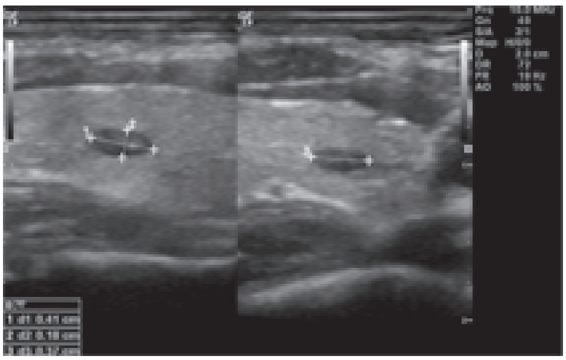


Fig. 2. Most of the IET lesions are located in the middle portion of the thyroid gland as seen on Fig. **2a** and **2b.**



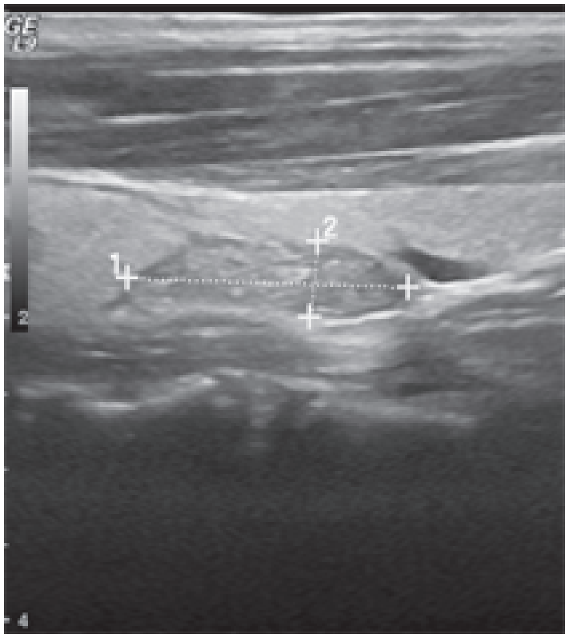
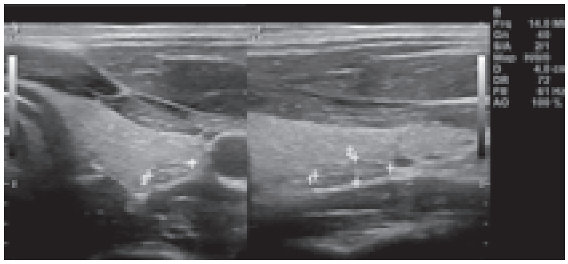


Fig. 3. Extension of IET to a border of the thyroid gland is a common imaging feature.



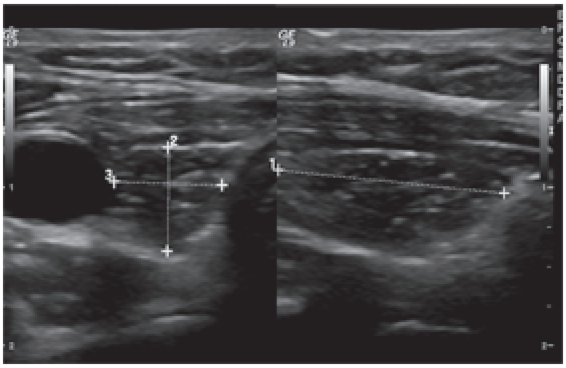
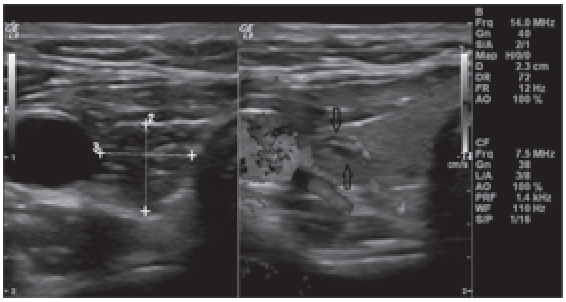


Fig. 4. Ectopic cervical thymus is marked on axial and longitudinal view on Fig. **4a.** The same ectopic cervical thymus and accompanying IET are isoechoic and seen on Fig. **4b.** Hypovascularity is a doppler ultrasound feature of the IET.



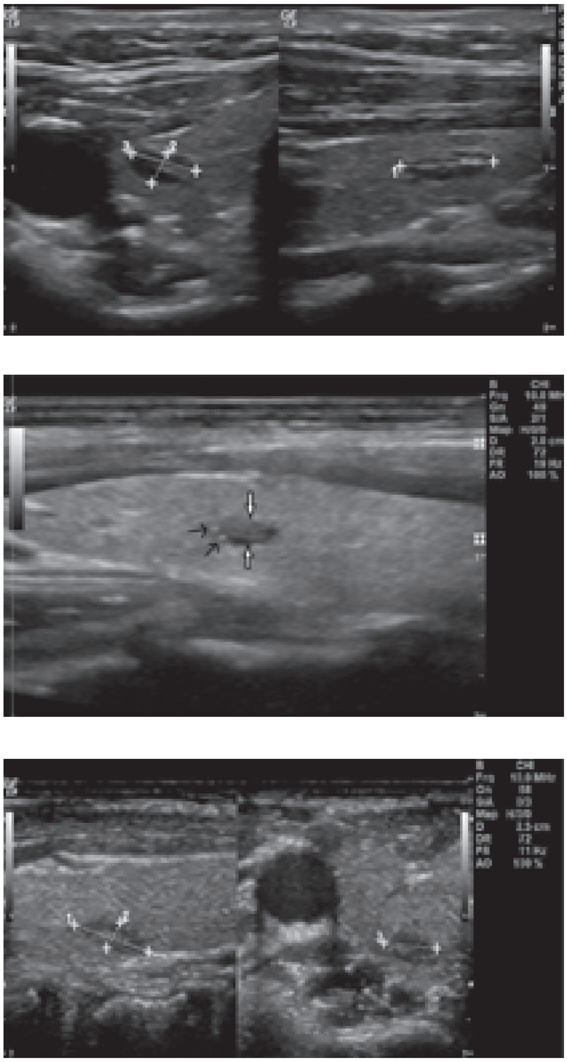


Fig. 6. The IETs signed with bold black arrows were generally hypoechoic (**Fig. 6a,6b,6c**). Thin, punctate echogenic foci are shown with thin black arrows within the IET **(Fig. 6b).**

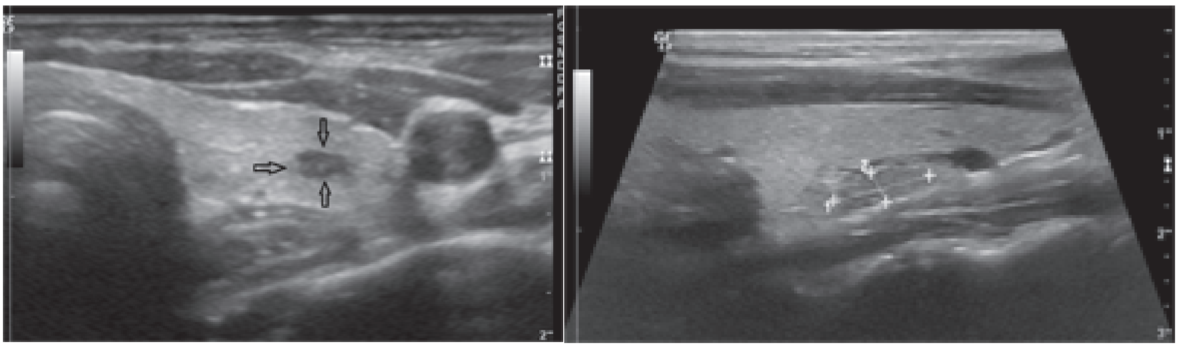


Fig. 5. An IET with a spherical shape (Fig. 5a) and another IET with a nonspherical shape (Fig. 5b) are seen.

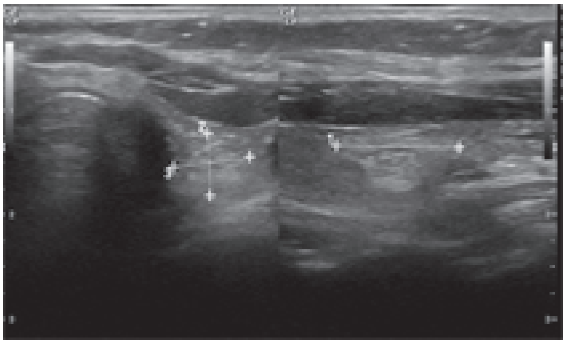
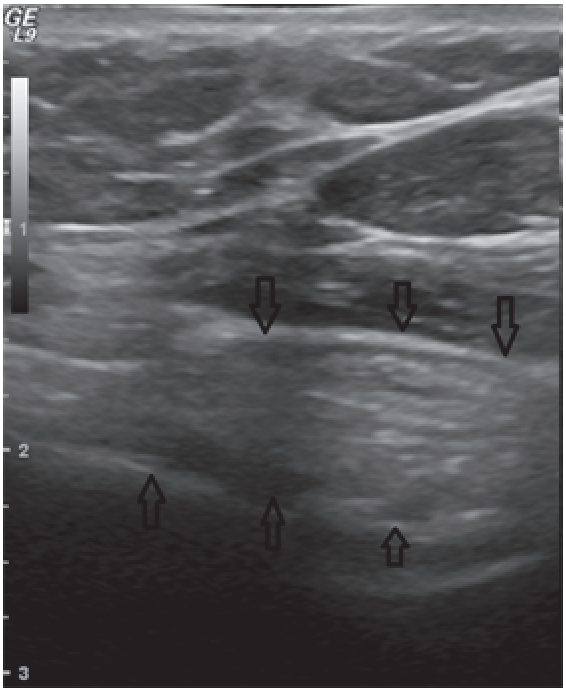


Fig. 7. The IET depicted in the elderly patient was hyperechoic to the thyroid gland while it is isoechoic to his thymus. His thymus which is seen from the thoracic inflow is signed with black arrows on **Fig. 7b.**



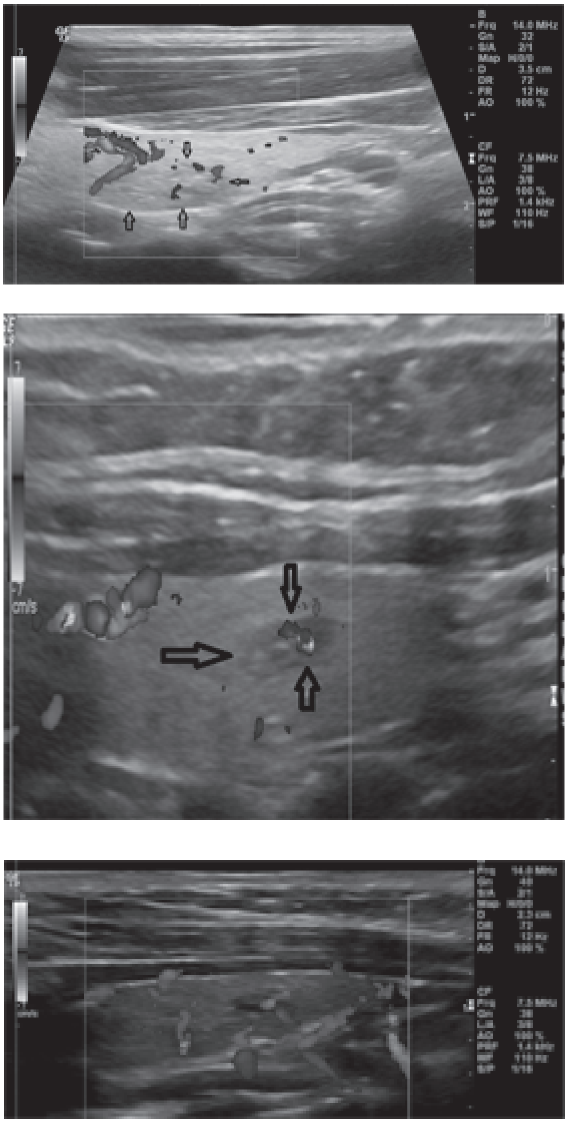


Fig. 8. One or more non-displaced vascular structure(s) traversing through the IETs were seen on Doppler ultrasound images without any rim vascularity.

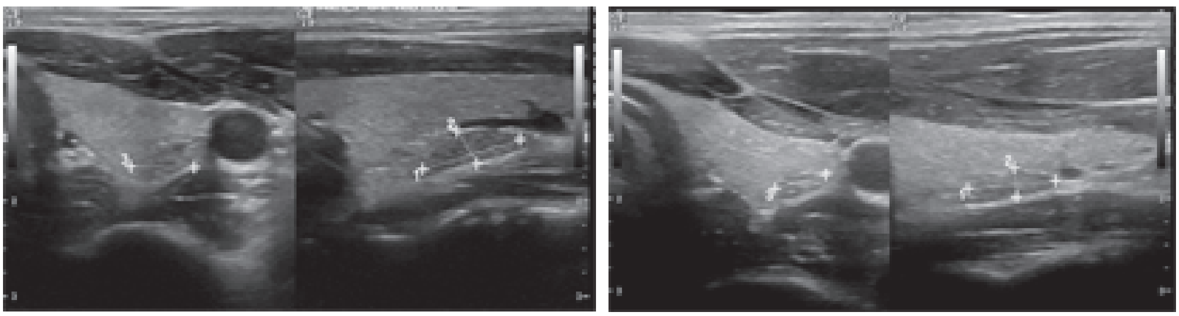


Fig. 9. The initial diameters **(Fig.9a)** and control diameters (**Fig.9b)** are shown. A millimetric regression on cc diameter was depicted.

initial examination. (p=0.007). We detected no significant difference between previous and control craniocaudal diameter values (p=0.415).

Discussion

The first report of intrathyroidal ectopic thymus as a pathological condition was made by Gilmour[7] in 1937. In a recent study, comprising the largest series to date and using US features as diagnostic criteria, the incidence of ectopic intrathyroidal thymus was reported to be 0.99% (375 among 37,816 children) in the general population.[8] We found an incidence of 0.91% among 3,914 thyroid glands subjected to US examinations between June 2012 and July 2015. We followed patients with lesions for 684±85 days, unlike in the series reported by Fukushima et al.[8] where no longitudinal follow-up was performed on the patients.

In the literature, the diagnosis of ectopic thymus is made by performing a fine-needle aspiration biopsy (FNAB) or surgery in the majority of individual cases.[5,6] Segni et al.[9] reported that none of the lesions detected showed progression during a mean follow-up period of 34 months in a US follow-up study of nine patients with an ectopic intrathyroidal thymus. We found no significant differences between previous and control anteroposterior (ap) and craniocaudal (cc) diameters, although the control diameters of the transverse (tr) dimensions were smaller than those of the previous ones. This regression may be linked to the age-related tendency toward thymic involution. In any case of increase in size of the IET a malignancy must be kept in differential diagnose in addition to rebound thymic enlargement.

A diagnosis of IET can be made only after benign and malignant nodules have been excluded.[10-12] By contrast to true thyroid nodules[13], the majority of lesions detected in our study were non-spherical in shape. Thyroid nodules tend to have their longest dimension in the craniocaudal direction; however, all three dimensions of IETs generally tend to have the same lengths.[14] By contrast, IET detected in this study had a craniocaudal diameter that was clearly longer than anteroposterior and transverse diameters (6.45 ±3.92 mm vs 3.1±1.19 mm, 4.89±1.86, respectively).

It is easy to differentiate a benign thyroid nodule from IET using echo structure. Benign thyroid nodules have a predominantly cystic component and a complete thin hypoechoic halo because pseudocapsules of fibrous connective tissue or compressed thyroid tissue and vessels are usually found around the nodule. Also, it is not difficult to differentiate an IET from a malignant nodule using US. Microcalcifications within a malignant thyroid nodule are distributed heterogeneously and show a posterior acustic shadow, although punctate echogenic foci seen in thymic tissue are uniform in size and distribution.

Features of IET using color power Doppler US were documented in a recent study which found hypovascularity in six lesions (55%) and vascularity in five lesions (45%).[15] In this study, 58% of the lesions did not show color code within IET or in the peripheral halo on color power Doppler US as expected from IET. This avascular nature may lead to misdiagnosis of IET as a benign avascular thyroid nodule. However, since an avascular nodule tends to

Table I. Descriptive Statistics of the Patients Age, Follow-up Period with Initial and Control Diameters in ap, tr and cc Dimensions.

Parameters	N	Minimum	Maximum	Mean	Std. Deviation
Age (day)	25	517.00	5,830.00	2,898.24	1,771.13
Follow-up (day)	27	34.00	604.00	198.44	145.40
Initial ap diameter (mm)	27	1.10	6.00	3.12	1.19
Initial tr diameter (mm)	27	1.60	8.40	4.89	1.86
Initial cc diameter (mm)	27	2.10	18.40	6.45	3.92
Control ap diameter (mm)	27	0.00	5.10	2.86	1.22
Control tr diameter (mm)	27	0.00	6.70	4.23	1.70
Control cc diameter (mm)	27	0.00	15.0	5.80	3.20

ap : anteroposterior, tr: transverse and cc: craniocaudal diameters

Table II. Common Characteristic Features of IET Arranged According to Frequency.

Parameters	Common	Moderate	Rare
Side	Left: 21 (58%)	Right: 9 (25%)	Both: 2 (6%)
On axial view	Middle: 19 (52%)	Lateral: 11 (30%)	Med: 4 (11%)
On long. view	Middle: 30 (83%)	Upper: 4 (11%)	Lower: 2 (5%)
Extension to a border	Lateral: 10 (25%)	Posterior: 8 (20%)	Medial: 7 (18%)
Shape	Non-spherical: 32 (89%)	Spheric: 4 (11%)	
Vascularity	No: 21 (58%)	Non-displaced vascularity: 15 (42%)	
Cervical ectopic thymus	No: 32 (89%)	Accompanying: 4 (11%)	
Echogenicity	Hypoechoic (98%)	Hyperechoic to the thyroid gland, isoechoic to thymus (2%)	
Millimetric echogenic foci	Include (100%)		
Mean diameter in initial diagnosis	cc: 6.45 ± 3.92mm	tr: 4.89 ± 1.86mm	ap: 3.1±1.19mm
Mean control diameter	cc: 5.8±3.2mm	tr: 4.26±1.64mm	ap: 2.9 ±1.19mm

ap: anteroposterior, tr: transverse and cc: craniocaudal diameters of IET

have a cystic nature, gray scale US features, based on harmonic imaging modality, can achieve correct diagnosis. The vessel codes were typically traversing through 42% of the IET. However, the vessel codes in solid thyroid nodules are confined within the nodule and demarcate its boundaries or surround the mass. Therefore, a hypervascular benign or malignant nodule can be easily differentiated from an IET because of a quite different echotexture.

Focal thyroiditis must be considered in differential diagnosis when IET is suggested. Both IET and focal throiditis have a mass effect; but focal throiditis is more hypoechoic than thymic tissue, does not include uniformly distributed echogenic foci within the lesion and has a poorly demarcated border. Increased vascularity on color power Doppler is more likely to be seen in focal thyroiditis.[4,16]

Yildiz et al.[15] found no lesions located in the upper pole of the thyroid gland, ten lesions in the mid portion (91%), and one lesion in the lower pole. In our study, the majority of the lesions were also located in mid portion (n=30, 83%). We found 4 IET located in the upper pole and 2 IET located in the lower pole. Hence, the mid portion of the thyroid gland is the most common location, but the location is not a predictive for IET diagnosis.

An IET may abut a surface of the thyroid gland or may be surrounded by the thyroid parenchyma (referred to as abutting and enclosed types, respectively in the literature). The abutting type is described as an IET connecting to the mediastinal thymus through the inferior or posterior surfaces of the thyroid gland[15,18] and was not included in our study. However, most of the lesions (25 lesions, 69%) included in the current study were abutting a border of the thyroid gland but did not exceed any border of the thyroid gland. Hence, this intermediate form can be described as a third type of IET. We demonstrated 8 IET abutted to the posterior, 7 IET abutted to the medial surface, and 10 IET abutted to the lateral surface in the previously described intermediate form IET (25 lesions, 69%).

The prevalence of cervical ectopic thymus is higher than thought according to a study reporting occurrence in 21% to 31% of children at autopsy.[19] Cervical ectopic thymus is a well known entity and cannot be misdiagnosed as a lymphadenopathy or anything else. Based on our data, the incidence of IET is less than the incidence of cervical ectopic thymus, but it is more than as we previously thought. Therefore, IET with a relatively high incidence is an extremely important entity as a confounding diagnosis.

The diagnosis of IET must be based on characteristic US features, and carries no need to perform a surgical intervention. Although the cases including one IET lesion were published in the literature, the incidence of IET is more common than though. The decrease in size, at least in one direction, supports the evolution of the IET. The follow-up periods for cases ranged widely in our study because of patient incompatibility.

In conclusion, the characteristic findings of this confusing entity are non-spherical shape, uniform distribution of punctate echogenic foci, absence of a rim, and the presence of vessels traversing through the lesion without displacement. The second step will be to perform an exam with a high-resolution US transducer (> 9 MHz). Here we report the identical imaging features and alterations in size of IET after a 22 month follow-up period. Finally, patients with a diagnosis of IET due to characteristic findings can be safely managed with US control without unnecessary biopsy or surgery. Healthcare professionals should be aware of IET and consider refraining from unnecessary interventions, potentially providing a reduction in psychological stress for pediatric patients and their families.

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