INTRODUCTION

Thyroid nodules in children and adolescents are uncommon, with an estimated incidence between 1% and 18% (1). However, the increasing availability of ultrasonographic examinations has resulted in accidental findings of many more thyroid lesions than previously reported. The risk of cancer in thyroid nodules in children is 22–26%, much higher than the 5–10% risk in adults (2). In accordance with current guidelines, any thyroid lesion found in children, except for pure cysts, requires a thorough diagnostic evaluation, including fine-needle aspiration biopsy (FNAB). In adults, FNAB is routinely recommended as follows: in cases with a high or intermediate suspicion of malignancy, if the nodule size is ≥ 1 cm; in low suspicion cases, if ≥ 1.5 cm; and when the conditions for the spongiform nodule are benign, if ≥ 2 cm (3). Unlike in adults, where lesion size criteria for conducting FNAB exist, in children, a FNAB should be performed even for small but suspicious nodules because children are smaller than adults (2).

The thymus has certain characteristic ultrasonographic features, which include a homogeneous background....
echogenicity similar to that of the liver or spleen, with scattered hyperechoic foci resembling a starry sky (4-10). Ectopic thymic tissue can be located anywhere along the descending path of the thymopharyngeal ducts (5, 11, 12). When ectopic thymic tissue abuts on the inferior or posterior surface of the thyroid or is enclosed by the thyroid parenchyma, the thymus is described as intrathyroidal (4-10). The intrathyroidal thymus has been considered a rare entity, a benign lesion that is unique to the pediatric population and generally requires no treatment (13). The incidence of ectopic intrathyroidal thymus is reported to be between 1% and 5% on screening ultrasonography (US). However, because US has become more frequently used in children, the characteristic features of intrathyroidal thymic tissue used to distinguish it from thyroid nodules have been reported more often, and this intrathyroidal thymus is now more frequently found as a common variant (8, 11-15). Until 2015, 59 cases of ectopic thymic tissue mimicking thyroid nodules or neoplasia detected on US had been published and more cases have been reported since (12, 13, 15-18). The US features of an intrathyroidal thymus are similar to those of a normal thymus. An intrathyroidal thymus may not be recognized by those who are not specialists in pediatric thyroid US, despite its characteristic US appearance. The US appearance of an intrathyroidal thymus can overlap with that of a thyroid nodule. Certain, characteristics leading to malignancy suspicion and misdiagnosis have resulted in children undergoing thyroid surgery for suspected malignancy that proved to be benign thymic tissue on surgical pathologic analysis (7, 8, 12-14, 19, 20). A few papers have reported on follow-up US of the intrathyroidal thymus in small numbers of patients (1, 6, 11, 13, 15, 18). The purpose of this study was to analyze the ultrasonographic features of the intrathyroidal thymus mimicking thyroid nodules, upon long-term follow-up, a large number of patients.

MATERIALS AND METHODS

This retrospective study was approved by the Institutional Review Board for Ethical Issues in Clinical Research. From January 2006 to December 2017, 1259 patients under 15 years of age who had undergone US for evaluation of congenital hypothyroidism were reviewed retrospectively. Thyroid US was one of the diagnostic protocols for patients diagnosed with congenital hypothyroidism in our hospital and follow-up thyroid US was performed. In this study, US findings such as aplasia, ectopy, or hemi-aplasia with an undefined thyroid gland in a normal position were excluded. US was performed by a pediatric radiologist or by residents under the supervision of the same pediatric radiologist. The US examinations were conducted using a 5–18 MHz high-frequency linear transducer or a hockey stick probe on one of two US scanners (IU 22, Philips Healthcare; or GE Logiq E9, GE Healthcare). A solid thyroid mass was seen in 52 lesions of 52 patients with a normally positioned thyroid gland. An intrathyroidal thymus was considered to be diagnosed when a hypoechoic lesion with punctate and linear echogenicity was observed. Areas of ectopic extrathyroidal tissue connected to the mediastinal thymus were not included in this study. Eleven patients were excluded because they did not have any US criteria characteristic of intrathyroidal thymus. If an image was available, the lesions were compared with the mediastinal thymus. Forty-one patients were diagnosed with an intrathyroidal thymus based on the US criteria from the previous reports (Fig. 1). All patients were diagnosed using US features. Patient characteristics, including age and sex and US features, including size, site, location, shape or margin were analyzed. The locations were classified as belonging to the superior, middle or inferior portion of the thyroid gland, on longitudinal scans. A lesion abutting the superior border of the thyroid was considered superior, one abutting the inferior border was considered inferior, and the others were considered as belonging to the middle portion.

| 1259 consecutive patients who underwent thyroid USG with congenital hypothyroidism younger than 15 years of age (January 2006–December 2017) |
|------------------------------------------------------------|
| 52 patients, suspected thyroid solid mass |
| - Hypoechoic solid lesion with punctate and linear echogenicity |
| - Compared with echogenicity of normal thymus |
| No characteristic sonographic features of thymus (n = 11) |
| 41 patients, ectopic intrathyroidal thymus (mean, 8.7 ± 11.6 months old) |
| 26 patients, available for sonographic long-term follow-up (mean follow-up interval, 55.6 ± 32.9 months) |

Fig. 1. Flow chart of study.
of the thyroid gland. On transverse scans, the locations of
the lesion were divided into anterior, center and posterior,
depending on whether the lesions abutted the anterior or
posterior border or neither. The lesion size measured on
the transverse and longitudinal scans was recorded and the
largest diameter among them was considered the maximum
diameter of the lesion. The shape was classified as oval,
round, or irregular. The margins were divided into well-
defined and indistinct/blurred.

Follow-up US was available for 26 patients and the last
follow-up US was performed within a range of 6 to 132
months (mean, 55.6 ± 32.9 months). The age at the last
follow-up US was between 1 and 14 years. The findings
from the last follow-up US were reviewed and compared
with the initial US for size, shape, margin, and echogenicity
pattern features. When changes of more than 2 mm in
any dimension were found between the initial and the
last follow-up US evaluation, the lesion was considered to
have decreased in size. The margin changes were divided
into two types: well-defined and indistinct/blurred. When
the echogenicity changed to a hyperechoic, from the
characteristic thymic echogenicity pattern, the pattern was
considered hyperechogenic. The changes in size on follow-
up US were compared to the changes in shape, margin, and
echogenicity pattern. The changes in size, shape, margin,
and echogenicity pattern were analyzed for associations
with the age of the last follow-up US. Statistical analysis
was performed with SPSS 20.0 (IBM Corp.) using chi-
squared tests and binary logistic regression analysis. A
difference was considered statistically significant for a
p-value of less than 0.05.

RESULTS

An intrathyroidal thymus was found in 3.3% (41/1259) of
patients, of which 24 were male and 17 female, with a mean
age of 8.7 ± 11.6 months (range, one week to 3 years 10
months). The mean maximum diameter was 7.3 ± 5.3 mm
(range, 3 to 25 mm). We were able to compare the scans of
31 patients who had scans of a mediastinal thymus. Twenty-
two (53.7%) patients had lesions on the right, and 19
(46.3%) had lesions on the left. The intrathyroidal thymus
was mostly located in the middle portion of the thyroid lobe
(33/41, 80.5%) and, less frequently, in the inferior portion
(8/41, 19.5%). No lesions were located in the superior
portion on longitudinal scans. There were 24 (58.5%)
lesions in the center of the gland and 17 (41.5%) in the
posterior portion on transverse scans. The lesions were oval
in 14 cases (34.1%), round in 23 (56.1%), and irregular in
four (9.8%). The margins of the lesions were well-defined
in 40 (97.6%) cases and indistinct or blurred in one (2.4%)
(Table 1).

During the follow-up period, 15 (57.7%, 15/26) lesions
were stable in size, and 11 (42.3%, 11/26) lesions decreased
in size, including one that disappeared. Ten (38.5%,
10/26) lesions had changed to indistinct, blurred margins
from initially well-defined margins (Figs. 2, 3). One case
of an initially indistinct margin also included indistinct,
blurred margins. Six (23.1%, 6/26) lesions changed to
hyperechogenic patterns from the initial characteristic
thymic echogenicity patterns (Figs. 4, 5). When the follow-
up size was compared to the changes in shape, margin, or
echogenicity pattern, a statistically significant difference
was seen between the size and the margin. Decreases in
size were significantly associated with changes to indistinct
or blurred margins (p = 0.004) (Table 2). However, no
statistical associations were found between decreases in
size and changes in shape or to hyperechogenic pattern. The
last follow-up age was significantly associated with changes
to hyperechoic patterns (odds ratio [OR], 2.141; 95%
confidence interval [CI], 1.144–4.010; p = 0.017) (Fig. 5).
However, other changes in size, shape, or margin type were
not significantly associated with the age at the last follow-
up (Table 3).

Table 1. Lesion Analysis of Intrathyroidal Thymus

|                      | Total | Right Lobe | Left Lobe |
|----------------------|-------|------------|-----------|
| **Longitudinal scan**|       |            |           |
| Superior             | 0 (0) | 0 (0)      | 0 (0)     |
| Middle               | 33 (80.5) | 15 (36.6) | 18 (43.9) |
| Inferior             | 8 (19.5) | 7 (17.1)  | 1 (2.4)   |
| **Transverse scan**  |       |            |           |
| Anterior             | 0 (0) | 0 (0)      | 0 (0)     |
| Center               | 24 (58.5) | 11 (26.8) | 13 (31.7) |
| Posterior            | 17 (41.5) | 11 (26.8) | 6 (14.6)  |
| **Shape**            |       |            |           |
| Oval                 | 14 (34.1) | 7 (17.1)  | 7 (17.1)  |
| Round                | 23 (56.1) | 12 (29.3) | 11 (26.8) |
| Irregular            | 4 (9.8)  | 3 (7.3)    | 1 (2.4)   |
| **Margin**           |       |            |           |
| Well-defined         | 40 (97.6) | 21 (51.2) | 19 (46.3) |
| Indistinct/Blurred   | 1 (2.4)  | 1 (2.4)    | 0 (0)     |
| **Total**            | 41 (100) | 22 (53.7) | 19 (46.3) |

Values are presented as n (%) unless otherwise indicated.
DISCUSSION

Some studies have confirmed that the presence of an intrathyroidal thymus through cytology or surgery due to the fear that children with suspicious thyroid lesions are misdiagnosed (4, 5, 12, 13, 15, 16, 21, 22). However, a few studies on the ultrasound characteristics and the prevalence of intrathyroidal thymus were based on US images only, without cytological evaluation, and suggested that US could be used as a common diagnostic tool to identify a benign intrathyroidal thymus (11, 13, 17, 23). In addition, awareness of the characteristic features of an intrathyroidal thymus and how they differ from the malignant finding and of the follow-up changes will be helpful for accurately diagnosing patients and determining the next procedures to be performed.

In previously reported studies investigating intrathyroidal thymus follow-up, an initial US was performed in 9 to 22 patients aged of 2.5 weeks to 17.5 years. In these studies, follow-up US was performed in 1 to 13 patients, at intervals ranging from 6 to 84 months (mean, 30.7 months) (1, 6, 11, 13, 15, 18). In our study, we analyzed the initial US findings of 41 patients with an average age of 8.7 months, with an intrathyroidal thymus. Follow-up US was performed
in 26 patients, at an interval of up to 132 months (mean, 55.6 months). To the best of our knowledge, this is the first study analyzing long-term US follow-up on intrathyroidal thymus cases, in the largest number of patients. The most important clues for an accurate differential diagnosis between an intrathyroidal thymus and thyroid nodules are the presence of a fusiform shape and well-defined margins and a characteristic hypoechoic solid mass with bright internal punctate or linear echogenicity, similar to the normally descended thymus (4, 5, 11, 16). In our study, most lesions were round and small (less than 10 mm) or oval in shape. Except for one, most lesions had well-defined margins. All cases of intrathyroidal thymus had US patterns similar to those of a normal thymus in the mediastinum.

Thymic involution is defined as the process in which the gland decreases in size and weight with advancing age (24). The process of age-related thymic involution remains poorly understood despite many reports examining age-related changes in thymic physiology (25). The thymus has the greatest relative size at birth and continues to grow until it reaches its greatest absolute size at puberty (11). Because the incidence of intrathyroidal thymus is inversely correlated with age, the intrathyroidal thymus would be expected to follow the same growth trends as normal thymic tissue, as they are derived from the same tissue (11, 23). Several follow-up studies reported that most lesions remained stable and some lesions shrank (6, 11, 13, 18). Segni et al. (6) reported that normal thymus involution occurs with advancing age, in patients aged 13 and 17 years. However, another study reported that thymus regression in puberty may occur earlier than previously reported, as smaller changes were observed at five or six years of age. It was also reported that many lesions were stable and no changes in shape, border, or echotextures were observed on follow-up imaging analysis (11, 13). Kabaalioğlu et al. (11) reported that one patient with an intrathyroidal thymus, diagnosed by FNAB, showed an increase in echogenicity and a less well-defined border in a follow-up at age five. These changes to increasing echogenicity and less well-defined borders have been observed during the involution phase of the thymus (6, 11). In our study, a decrease in lesion size was seen in 42.3% (11/26) of the patients. One lesion had disappeared in a 3-year-old at the follow-up, which is too young of an age to have coincided with thymic involution. On follow-up, the decrease in the size of the lesion was

![Serial follow-up images of intrathyroidal thymus.](image)

**Table 2. Comparison of Follow-Up Size, Shape, Margin, and Echogenicity Patterns**

|                | Size   | Shape | P  | Margin      | P              | Echogenicity Pattern | P  |
|----------------|--------|-------|----|-------------|------------------|---------------------|----|
|                | Total  | Oval  | Round | Irregular | Well-Defined | Indistinct/Blurred | P  | Isoechogenicity | Hyperechogenicity |
| Stable         | 15     | 6 (31.3) | 6 (31.3) | 4 (26.7) | 13 (86.7) | 2 (13.3) | 10 (83.3) | 5 (41.7) |
| Smaller        | 11     | 3 (27.3) | 2 (18.2) | 6 (54.5)* | 3 (27.3) | 8 (72.7)** | 10 (90.9)** | 1 (9.1) |
| Total          | 26     | 8 (30.8) | 8 (30.8) | 10 (38.5) | 16 (61.5) | 10 (38.5) | 20 (76.9) | 6 (23.1) |

Values are presented as n (%) unless otherwise indicated. *Disappeared one patient, †Initially indistinct, blurred margin one patient, ‡Similar echogenicity to that of thymus.
significantly associated with changes to blurred margins. However, one patient with a margin which was not well-defined on the initial US was aged two. This could pose a problem in the achieving an accurate differential diagnosis from a malignant thyroid nodule. Knowing that a decrease in intrathyroidal thymus size could be associated with a change to a blurred margin can help in recognizing an incidentally found intrathyroidal thymus and provide information for a correct differential diagnosis from a malignant thyroid nodule in children. In our study, hyperechoic changes from the thymic echogenicity pattern were significantly associated with the last follow-up age and this could represent the thymic involution process of fatty replacement. The US internal echogenicity of the intrathyroidal thymus is known to correspond to fat or connective tissue septa and vessels in the thymic tissue (11, 16). During the involution phase, the atrophy of the epithelial component results in a fatty replacement of the cellular components of the thymus and may induce a hyperechoic change from the normal thymic echogenicity pattern.

US features suggestive of malignant thyroid nodules include the presence of microcalcifications, irregular margins, taller than wide dimensions, hypoechoic solid nodules, increased vascularity, and abnormal lymph nodes (9, 16, 26). Children with hypoechoic nodules with microcalcification-like echogenicity are often referred for biopsy or surgery due to a strong suspicion of malignancy (11, 13, 17, 23). The diffuse sclerosing variant of papillary thyroid carcinoma tends to have a diffuse pattern of microcalcifications imparting a snowstorm appearance on ultrasound. It also tends to be more commonly reported in young patients, while being associated with a worse prognosis than conventional papillary carcinoma (16, 27). Punctate bright internal echogenicity in the intrathyroidal thymus are most commonly confused with microcalcifications, such as the diffuse sclerosing variant of papillary carcinoma, which can truly mimic thymic tissue on US. To avoid a missed or delayed diagnosis, clinicians may prompt referral to US-guided FNAB (16).

Although there is considerable overlap between the ultrasound findings of benign and malignant thyroid nodules, knowledge of the typical ultrasound features of an intrathyroidal thymus can help with differentiating it from other thyroid lesions and assist in making a definite diagnosis based on ultrasound. In addition, there is limited age overlap between the patients with an intrathyroidal thymus and those with thyroid malignancies, because the prevalence of thyroid malignancies increases with age and the intrathyroidal thymus spontaneously involutes in late childhood (16). At follow-up, most of our patients did not show any problems or complications related to an intrathyroidal thymus. Therefore, if an incidentally found thyroid nodule in children displays the characteristic US appearance of an intrathyroidal thymus that can be compared with a normal mediastinal thymus, additional evaluation may not be necessary. However, in some phase of involution, the intrathyroidal thymus could have certain characteristics, such as an indistinct margin, irregular appearance, or internal echogenicity mimicking microcalcifications that are similar to those of thyroid malignancies. If the other US lesion findings lead to a suspicion for an intrathyroidal thymus, but there is, in young children, an indistinct margin, irregular appearance, or internal echogenicity mimicking microcalcifications, regular follow-up US may be recommended until the intrathyroidal thymus decreases in size or changes to hyper-echoic patterns in order to differentiate it from malignancy. However, if these US findings were seen in older children or adolescents, US-guided FNAB should be recommended to the patient. Distinguishing suspicious thyroid nodules from an intrathyroidal thymus using US requires a great deal of experience with the intrathyroidal thymus. Thus,

| Features at Last Follow-Up | β (SE) | Odds Ratio | 95% Confidence Interval | P   |
|---------------------------|--------|------------|------------------------|-----|
| Size                      |        |            |                        |     |
| No change                 | -0.032 (0.126) | 0.968 | 0.756–1.240 | 0.799 |
| Decreased or disappeared  |        |            |                        |     |
| Shape                     |        |            |                        |     |
| Oval, round               | 0.020 (0.126) | 1.020 | 0.796–1.306 | 0.876 |
| Irregular                 |        |            |                        |     |
| Margin                    |        |            |                        |     |
| Well-defined              | -0.045 (0.130) | 0.956 | 0.741–1.232 | 0.726 |
| Indistinct/Blurred        |        |            |                        |     |
| Echogenicity pattern      |        |            |                        |     |
| Isoechoogenicity*          | 0.761 (0.320) | 2.141 | 1.114–4.010 | 0.017 |
| Hyerechogenicity           |        |            |                        |     |

*Similar echogenicity to that of thymus. SE = standard error
if the radiologist or the clinician is knowledgeable in the benign characteristics of the intrathyroidal thymus and its long-term changes, patients can avoid further unnecessary invasive procedures such as FNAB or surgery (13).

There were several limitations to our study. First, it was a retrospective review of thyroid US and the incidence of intrathyroidal thymus may have been underestimated. Second, all patients were diagnosed by US findings and none of them had a pathologic diagnosis. Therefore, the possibility of misdiagnosis cannot be excluded. Third, many of the intrathyroidal thymus had subcentimeter sizes of less than 10 mm and comparing changes in small lesions may not be accurate. Fourth, the follow-up age distribution was not even and only two patients were available at follow-up ages of over 10 years old. Finally, because the lesions are expected to disappear following puberty, we were not able to observe regression in all our patients.

In conclusion, an intrathyroidal thymus appears as a round or oval, circumscribed, hypoechoic mass with the characteristic echogenicity features of the thymus. On follow-up US, an intrathyroidal thymus may be decreased in size, with indistinct or blurred margins, or changed to a hyperechoic mass. Decreases in size may be associated with changes to indistinct margins. A change to a hyperechoic pattern in the intrathyroidal thymus may be associated with increasing age. Awareness of the characteristic US features and follow-up changes in an intrathyroidal thymus in children is important to avoid misdiagnosing it as a malignant nodule and unnecessary interventional procedures or surgery.

Conflicts of Interest
The authors have no potential conflicts of interest to disclose.

ORCID iDs
Yun-Woo Chang
https://orcid.org/0000-0001-9704-8112
Hee Min Kang
https://orcid.org/0000-0003-1359-2810
Eun Ji Lee
https://orcid.org/0000-0002-4860-2495

REFERENCES
1. Avula S, Daneman A, Navarro OM, Moineddin R, Urbach S, Daneman D. Incidental thyroid abnormalities identified on neck US for non-thyroid disorders. Pediatr Radiol 2010;40:1774-1780
2. Francis GL, Waguespack SG, Bauer AJ, Angelos P, Benvenga S, Cerutti JM, et al. Management guidelines for children with thyroid nodules and differentiated thyroid cancer. Thyroid 2015;25:716-759
3. Shin JH, Baek JH, Chung J, Ha EJ, Kim JH, Lee YH, et al. Ultrasonography diagnosis and imaging-based management of thyroid nodules: revised Korean Society of Thyroid Radiology consensus statement and recommendations. Korean J Radiol 2016;17:370-395
4. Yiilidiz AE, Ceyhan K, Siklar Z, Bilir P, Yag˘murlu EA, Berbero˘glu M, et al. Intrathyroidal ectopic thymus in children: retrospective analysis of grayscale and doppler sonographic features. J Ultrasound Med 2015;34:1651-1656
5. Kim HG, Kim MJ, Lee MJ. Sonographic appearance of intrathyroidal ectopic thymus in children. J Clin Ultrasound 2012;40:266-271
6. Segni M, di Nardo R, Pucarelli I, Biffoni M. Ectopic intrathyroidal thymus in children: a long-term follow-up study. Horm Res Paediatr 2011;75:258-263
7. Gimmi O, Krause U, Wessel H, Finke R, Dralle H. Ectopic intrathyroidal thymus diagnosed as a solid thyroid lesion: case report and review of the literature. J Pediatr Surg 1997;32:1241-1243
8. Hernandez-Cassis C, Poniecka A, Vogel CK, McKenzie JM. A six-year-old boy with a suspicious thyroid nodule: intrathyroidal thymic tissue. Thyroid 2008;18:377-380
9. Megremis S, Stiakaki E, Trifou I, Bonapart IE, Tsilimigaki A. Ectopic intrathyroidal thymus misdiagnosed as a thyroid nodule: sonographic appearance. J Clin Ultrasound 2008;36:443-447
10. Patel MN, Komlos M, Racadio JM. Intrathyroidal thymic tissue mimicking a thyroid nodule in a 4-year-old child. J Clin Ultrasound 2013;41:319-320
11. Kabaaliog˘lu A, Öztek MA, Kesimali U, Çeken K, Durmaz E, Apaydn A. Intrathyroidal ectopic thymus in children: a sonographic survey. Med Ultrason 2017;19:179-184
12. Stasiak M, Adamczewski Z, Stawerska R, Krawczyk T, Tomaszewska M, Lewińska A. Sonographic and elastographic features of extra- and intrathyroidal ectopic thymus mimicking malignancy: differential diagnosis in children. Front Endocrinol (Lausanne) 2019;10:223
13. Frates MC, Benson CB, Dorfman DM, Cibas ES, Huang SA. Ectopic intrathyroidal thymic tissue mimicking thyroid nodules in children. J Ultrasound Med 2018;37:783-791
14. Courcoutsakis N, Patronas N, Filie AC, Carney JA, Moraitis A, Stratakis CA. Ectopic thymus presenting as a thyroid nodule in a patient with the Carney complex. Thyroid 2009;19:293-296
15. Bang MH, Shin J, Lee KS, Kang MJ. Intrathyroidal ectopic thymus in children: a benign lesion. Medicine (Baltimore) 2018;97:e0282
16. Escobar FA, Pantanowitz L, Picarsic JL, Craig FE, Simons JP,
Viswanathan PA, et al. Cytomorphology and sonographic features of ectopic thymic tissue diagnosed in paediatric FNA biopsies. *Cytopathology* 2018;29:241-246

17. Yıldız AE, Elhan AH, Fitöz S. Prevalence and sonographic features of ectopic thyroidal thymus in children: a retrospective analysis. *J Clin Ultrasound* 2018;46:375-379

18. Aydı̇n S, Fatihoglu E, Kacar M. Intrathyroidal ectopic thymus tissue: a diagnostic challenge. *Radiol Med* 2019;124:505-509

19. Lignitz S, Musholt TJ, Kreft A, Engel R, Brzezinska R, Pohlenz J. Intrathyroidal thymic tissue surrounding an intrathyroidal parathyroid gland, the cause of a solitary thyroid nodule in a 6-year-old boy. *Thyroid* 2008;18:1125-1130

20. Durmaz E, Barsal E, Parlak M, Gurer I, Karaguzel G, Akcurin S, et al. Intrathyroidal ectopic thymic tissue may mimic thyroid cancer: a case report. *J Pediatr Endocrinol Metab* 2012;25:997-1000

21. Chng CL, Kocjan G, Kurzawinski TR, Beale T. Intrathyroidal ectopic thymic tissue mimicking thyroid cancer in children. *Endocr Pract* 2014;20:e241-e245

22. Park SH, Ryu CW, Kim GY, Shim KS. Intrathyroidal thymic tissue mimicking a malignant thyroid nodule in a 4-year-old child. *Ultrasonography* 2014;33:71-73

23. Fukushima T, Suzuki S, Ohira T, Shimura H, Midorikawa S, Ohtsuru A, et al. Prevalence of ectopic intrathyroidal thymus in Japan: the Fukushima health management survey. *Thyroid* 2015;25:534-537

24. Nishino M, Ashiku SK, Kocher ON, Thurer RL, Boiselle PM, Hatabu H. The thymus: a comprehensive review. *Radiographics* 2006;26:335-348

25. Taub DD, Longo DL. Insights into thymic aging and regeneration. *Immunol Rev* 2005;205:72-93

26. Nasseri F, Eftekhari F. Clinical and radiologic review of the normal and abnormal thymus: pearls and pitfalls. *Radiographics* 2010;30:413-428

27. Kim HS, Han BK, Shin JH, Ko EY, Sung CO, Oh YL, et al. Papillary thyroid carcinoma of a diffuse sclerosing variant: ultrasonographic monitoring from a normal thyroid gland to mass formation. *Korean J Radiol* 2010;11:579-582