Pediatric Thyroid Nodules: Ultrasound Characteristics as Indicators of Malignancy

Brandon Fornwalt, DO1, Manasa Melachuri2, Matthew Kubina2, Janice McDaniel, MD2,3, and Anita Jeyakumar, MD, MS1,2*

Abstract

Objective. Pediatric thyroid nodules are uncommon but carry a 25% malignancy risk. Adult patients have well-established ultrasound characteristics that are predictive of malignancy, but these are not clearly defined in pediatric patients. We reviewed a case series of pediatric thyroid nodules.

Study Design. Retrospective chart review.

Setting. Tertiary children’s hospital.

Method. Institutional review board approval was obtained. This case series with chart review includes all pediatric thyroid nodules with ultrasounds from 2006 to 2016 at 2 tertiary care centers.

Results. An overall 112 pediatric thyroid nodules were analyzed. The mean patient age was 14.3 years; there was a female: male ratio of 4:1; and 94% were Caucasian. Seventeen percent (20/112) of nodules were malignant. In patients with malignant nodules, the average presenting age was 15.5 years, with a female:male ratio of 5.6:1. Seventy percent of malignant nodules had accompanying microcalcifications, 55% had abnormal lymph nodes, and 45% had irregular margins. In the benign nodules, 11% had microcalcifications, 12% had abnormal lymph nodes, and 26% had irregular margins. The presence of microcalcifications (odds ratio, 19.1 [95% CI, 6.0-61.0]; P < .0001), abnormal lymph nodes (odds ratio, 9.0 [95% CI, 3.0-26.6]; P = .0001), and size >3.5 cm (odds ratio, 5.8 [95% CI, 1.5-22.5]; P = .01) was associated with thyroid cancer. Irregular margins were not statistically significant (odds ratio, 2.3 [95% CI, 0.86-6.3]; P = .9).

Conclusions. Our data suggest that abnormal lymph nodes, microcalcifications, and size >3.5 cm could be predictors of malignancy in the pediatric population and influence clinical decision making.

Keywords
pediatric thyroid nodules, ultrasound-guided fine-needle aspiration, thyroid cancer

Received September 14, 2021; accepted December 19, 2021.

Thyroid nodules in children have an incidence of only 0.1% to 5%, as opposed to 68% in adults. However, the rate of pediatric malignancy is 22% to 26%, as compared with 5% to 10% in adults.1-3 The literature has demonstrated that pediatric thyroid cancer is more advanced upon presentation, holds a greater risk of recurrence, and is more likely to metastasize to the lymph nodes and lungs.3 In addition to a detailed history and physical examination, diagnostic interventions such as ultrasound-guided fine-needle aspiration biopsy (US FNAB) help delineate benign vs malignant disease and dictate the course of disease management. The American Thyroid Association (ATA) and TI-RADS (Thyroid Imaging, Reporting and Data System) standardized the description of thyroid nodules and stratified the risk of characteristics in adults.4 The standardization was extended to thyroid nodules in children with a greater emphasis on US characteristics rather than size.5,6 The predictive value of these characteristics is varied in children, and few studies have identified US characteristics most predictive of malignancy among pediatric thyroid nodules.

Abnormal-appearing lymph nodes, microcalcifications, and irregular margins are the most agreed-on US characteristics predictive of malignancy in children. A rounded lymph node with mass effects, diffusely increased vascularity, or a small/ absent hilum is considered abnormal.3 A microcalcification is seen on US as punctate foci <1 cm with no posterior acoustic shadowing. Nodules with jagged or spiculated edges are defined as irregular, while margins difficult to distinguish from background are ill-defined nodules. Despite high specificity, these characteristics rarely occur, leading to a lower

1Department of Otolaryngology, Mercy Bon Secours, Youngstown, Ohio, USA
2Northeast Ohio Medical University, Rootstown, Ohio, USA
3Department of Radiology, Akron Children’s Hospital, Akron, Ohio, USA

This article was presented at the 2021 AAO-HNSF Annual Meeting & OTO Experience; October 3-6, 2021; Los Angeles, California.

Corresponding Author:
Anita Jeyakumar, MD, MS, Department of Otolaryngology, Mercy Bon Secours, 8423 Market St, Youngstown, OH 44512, USA.
Email: ajeyakumar@mercy.com

DOI: 10.1177/2473974X211073702
http://oto-open.org

Article reuse guidelines: sagepub.com/journals-permissions

This Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (http://creativecommons.org/licenses/by-nc/4.0/) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (https://us.sagepub.com/en-us/nam/open-access-at-sage).
rate of sensitivity.\(^6\)\(^7\) Additional, less universally accepted features include larger size, solid parenchyma, and taller-than-wide shape.\(^8\) Indeterminate results on US FNAB have variable treatment options, such as repeat US FNAB or biopsy/lobectomy.

A greater consensus on the predictive ability of US findings to differentiate benign vs malignant on initial US FNAB will minimize repeat or potentially unnecessary US FNAB or surgery. Our study objective is to further identify US characteristics of pediatric thyroid nodules that are most predictive of malignancy.

**Materials and Methods**

Approval was obtained from the Akron Children’s Hospital institutional review board. All patients who underwent an US FNAB of the thyroid or thyroid nodules between 2006 and 2016 at a tertiary children’s hospital were included with ICD-9 and ICD-10 code E041 (thyroid nodule; *International Classification of Diseases, Ninth Revision and Tenth Revision*). Patients lacking US records, pathologic information, or operative reports were excluded. Patients with no nodules who underwent FNAB were also excluded. Information regarding patient demographics, clinical information (eg, imaging, cytopathologic, and histopathologic results of US FNAB), and surgical specimens was attained from the electronic medical records. All cases were reviewed by a pathologist and interventional radiologist.

**Nodule Characterization**

The location of nodules was determined from the US. Location was described as in the anterior or posterior portion within the lobe, in the mid, superior, or inferior pole. Size dimensions were described as the diameter of the anteroposterior, transverse, and sagittal length. The composition of each nodule was noted as homogeneously solid, homogeneous cystic, or heterogenous. Echogenicity of the nodule was compared with the surrounding thyroid gland; hyperechogenicity, peripheral echogenicity, hypoechoic, and/or artifact. The margins of each nodule were defined as well-defined, indeterminate, irregular, and/or infiltrated. Elastography was rarely found in patient charts. Total thyroid composition, echogenicity, septations, and foci were recorded when abnormal or significant.

Fine-needle aspiration pathology was classified per the Bethesda System for Reporting Thyroid Cytopathology as follows: benign, Hashimoto thyroiditis, atypical or cells of undetermined significance, papillary carcinoma, follicular neoplasm, or nondiagnostic due to insufficient cellular material.

**Statistical Analysis**

The results were analyzed per patient. The presence of US characteristics for the prediction of malignancy was assessed by sensitivity, specificity, negative predictive value, positive predictive value, and odds ratio (OR). To determine which demographic and sonographic features were associated with thyroid cancer, Fisher exact and \(\chi^2\) analyses were used for categorical variables. For continuous variables, the Student \(t\) test and logistic regression analyses were used. The results with \(P\) values \(\leq 0.05\) were considered statistically significant. Software programs were used for statistical analyses (www.vassarstats.net; Systat version 9, IBM SPSS Statistics).

**Results**

An overall 112 pediatric patients were found to have thyroid nodules, of which 20 were malignant. The mean patient age was 14.3 years (range, 2-18). The female: male ratio was 4:1. Ninety-one patients were female and 105 were Caucasian. Forty-two patients had preexisting thyroid disease (Hashimoto, Graves, congenital hypothyroidism, hypothyroidism) and were taking thyroid replacement therapy (methimazole and levothyroxine sodium). More than half of patients presented with symptoms in an appointment outside of a well child visit. The demographic information is summarized in *Table 1*.

Among patients with malignant nodules, the average presenting age was 15.5 years, with a female: male ratio of 5.6:1. Seventeen patients were female and all were Caucasian. Papillary carcinoma was found in 18 patients and follicular cancer in 2. The presence of microcalcifications increased with malignancy (14 of 20 vs 10 of 92; \(OR, 19.1 \ [95\% CI, 5.9-61.0]; \ P < .0001\)). Abnormal lymph nodes also increased with malignancy (11 of 20 vs 11 of 92; \(OR, 9.0 \ [95\% CI, 3.0-26.6]; \ P = .0001\)). Irregular margins were not more prevalent in malignant nodules (9 of 20 vs 24 of 92; \(OR, 2.3 \ [95\% CI, 0.9-6.3]; \ P = .0981\)).

Size \(>3.5\) cm was nearly 5 times more common in malignant nodules (5 of 20 vs 5 of 92; \(OR, 5.8 \ [95\% CI, 1.5-22.5]; \ P = .0110\)). Five patients had nodules \(>3.5\) cm. Two patients had nodules between 2 and 3.5 cm. Clinical characteristics are presented in *Table 1*.

Fifty-five percent of malignant nodules were solitary; 7 patients had multiple nodules; and 2 patients had no nodule at presentation. Five patients with no nodules who underwent FNAB were excluded. Composition, vascularity, echogenicity, and family history were not associated with greater malignancy. Heterogenous nodules were not associated with a statistically higher risk of malignancy. The test characteristics, ORs, and 95% CIs are shown in *Table 2 and 3*.

In patients with benign nodules, 10 patients had microcalcifications, 11 had abnormal lymph nodes, 24 had irregular margins, and 5 had nodules \(>3.5\) cm. The presence of
microcalcifications (OR, 19.1 [95% CI, 5.9-61.0]; P < .0001), abnormal lymph nodes (OR, 9.0 [95% CI, 3.0-26.6]; P = .0001), and size >3.5 cm (OR, 5.8 [95% CI, 1.5-22.5]; P = .0110) was associated with thyroid cancer. Irregular margins did not prove statistically significant (OR, 2.3 [95% CI, 0.9-6.3]; P = .0981).

### Table 1. Nodule Characteristics.

|                      | Patients with nodules, No. (%) |
|----------------------|---------------------------------|
|                      | All  | Benign | Malignant |
| All                  | 112  | 92/112 (82.14) | 20/112 (17.86) |
| Male                 | 21 (18.75) | 18/21 (85.71) | 3/21 (14.29) |
| Female               | 91 (81.25) | 74/91 (81.31) | 17/91 (18.68) |
| Caucasian            | 105 (93.75) | 85/105 (80.95) | 20/105 (19.05) |
| Abnormal lymph nodes | 22 (19.64) | 11 (11.96) | 11 (55) |
| Microcalcifications  | 24 (21.42) | 10 (10.87) | 14 (70) |
| Irregular margins    | 33 (29.46) | 24 (26.09) | 9 (45) |
| Size, cm             |      |        |          |
| <2                   | 65 (58.04) | 55 (59.78) | 10 (50) |
| 2-3.5                | 27 (24.11) | 25 (27.17) | 2 (10) |
| >3.5                 | 10 (8.93) | 5 (5.43) | 5 (25) |
| Age ≥10 y            | 105 (93.75) | 85 (92.39) | 20 (100) |
| Preexisting thyroid disease | 42 (37.50) | 35 (38.04) | 7 (35) |
| Thyroid replacement  | 42 (37.50) | 35 (38.04) | 7 (35) |
| Symptoms             | 64 (57.14) | 53 (57.60) | 11 (55) |

* Methimazole, n = 3; levothyroxine sodium (Synthroid), n = 32.

### Table 2. Odds Ratio for Thyroid Nodule Characteristics.

|                                | Odds ratio (95% CI) | P value |
|--------------------------------|---------------------|---------|
| Abnormal lymph nodes           | 9.00 (3.0474-26.5800) | .0001   |
| Microcalcifications             | 19.13 (5.9978-61.0360) | <.0001  |
| Irregular margins               | 2.32 (0.8560-6.2783)  | .0981   |
| Size, cm                        |                     |         |
| <2                              | 0.67 (0.2549-1.7756)  | .4234   |
| 2-3.5                           | 0.30 (0.0644-1.3771)  | .1210   |
| >3.5                            | 5.80 (1.4956-22.4925) | .0110   |
| Composition                     |                     |         |
| Homogeneously solid             | 0.27                | .2187   |
| Heterogeneously solid and cystic| 0.78 (0.2966-2.0689) | .4028   |
| Cystic                          | 1.17 (0.2284-5.9605)  | .5656   |
| Vascularity                     |                     |         |
| Hypervascular                   | 1.24 (0.4724-3.2753)  | .4212   |
| Hypovascular                    | 1.47 (0.4699-4.6023)  | .3484   |
| Echogenicity                    |                     |         |
| Hyperechoic                     | 2.03 (0.6288-6.5257)  | .1901   |
| Hypoechoic                      | 1.56 (0.5889-4.1092)  | .25805  |
| Family history                  |                     |         |
| Thyroid disease                 | 1.37 (0.4402-4.2663)  | .39117  |
| Cancer or nodules               | 0.90 (0.2704-2.9955)  | .5658   |
| No. of nodules                  |                     |         |
| >1                              | 0.43 (0.1582-1.1845)  | .078896 |
| 1                               | 1.52 (0.5751-4.0192)  | .2735   |
US is widely accepted as the most sensitive imaging modality for nodule detection and routine interval monitoring. US FNAB is the gold standard in identifying malignant nodules according to the ATA. According to the 2015 guidelines proposed by the ATA Guidelines Task Force on Pediatric Thyroid Cancer, pediatric cases should be classified on the extent of disease and stratified into risk levels according to the AJCC TNM system.

Abnormal-appearing lymph nodes, microcalcifications, irregular margins, larger size, solid composition, increased blood flow, and hypoechogenicity are commonly recognized US characteristics most predictive of malignancy in adults. However, there are varying reports of the predictability in US characteristics in pediatric patients.

In a study evaluating 404 thyroid nodules (314 patients), Richman et al determined the criteria of the American College of Radiology’s TI-RADS to be inadequate in assessing the risk of pediatric thyroid nodules, as it would have missed 21% of malignant cases. A size criterion for the pediatric population, in which the thyroid volume changes as children grow, can be problematic. Varying accounts of predictability require a large study to understand and help standardize the most important guidelines for indeterminate nodules after US FNAB.

Our study supports accepted literature on the higher rate of malignant nodules in children (18%) than adults (5%-10%). It also supports literature on the predictive value of microcalcifications, abnormal lymph nodes, and size. However, irregular margins, hypoechogenic nodules, and vascularization did not prove to be statistically significant predictors in our study. A nodule with microcalcifications was 19 times more likely to be malignant than a nodule without microcalcifications. The presence of microcalcifications is the strongest predictor of malignancy and shows a specificity of 90% and a sensitivity of 70%.

Patients with abnormal lymph nodes are 9 times more likely to have malignant nodules. Nodules that were >3.5 cm in diameter were highly specific (95%) but not sensitive (25%) in predicting malignancy. Larger nodules were 5.8 times more likely to be malignant. Irregular borders were not statistically significant.

Ninety-four percent of the children in our study were Caucasian, and all malignant nodules were found in Caucasian children. Females are generally more likely to present with nodules. In our study 6 times as many females were likely to have malignant nodules when compared with their male counterparts. The incidence of thyroid nodules rises after females go through puberty; this is hypothesized to be an effect of estrogen.

All our patients with malignant nodules were >10 years old. The predilection for females to develop benign nodules proved significant, with a female: male ratio of 3.8:1. These demographic characteristics are consistent with previous literature.

Most patients who underwent US FNAB proved to have benign nodules (96/116, 82%). The abnormal characteristics found in malignant nodules—irregular margins, abnormal lymph nodes, and microcalcifications—were much less common with prevalences of 26%, 12%, and 11%, respectively. Over 95% of benign nodules were <3.5 cm in diameter.

With improvements in US technology, additional characteristics have been hypothesized and studied in pediatric thyroid nodules and lymph nodes. Ríos et al analyzed 221 pediatric thyroid nodules with US and elastography and reported 100% specificity in determining benign nodules. Elastography has recently risen as a noninvasive imaging technique for differentiating between benign and malignant nodules. A study by Ríos et al found elastography to be 96% sensitive and 98% specific in differentiating benign from malignant nodules. However, further research is needed to establish its role in the management of pediatric thyroid nodules.

**Table 3. Test Characteristics.**

| Characteristic | Specificity | Sensitivity | PPV | NPV |
|---------------|-------------|-------------|-----|-----|
| Abnormal lymph nodes | 88 | 55 | 50 | 90 |
| Microcalcifications | 89.8 | 70 | 58.3 | 93.2 |
| Irregular margins | 73.9 | 45 | 27.3 | 86.1 |
| Size, cm | | | | |
| >2 | 40.2 | 50 | 58 | 41.9 |
| 2-3.5 | 72.8 | 10 | 7.4 | 78.8 |
| >3.5 | 94.6 | 25 | 50 | 85.3 |
| Composition | | | | |
| Homogeneously solid | 83.7 | 5 | 6.3 | 80.2 |
| Heterogeneously solid and cystic | 48.9 | 45 | 16.1 | 80.4 |
| Cystic | 91.3 | 10 | 20 | 82.4 |
| Vascularity | | | | |
| Hypervascular | 55.4 | 50 | 19.6 | 83.6 |
| Hypovascular | 81.5 | 25 | 22.7 | 83.3 |
| Echogenicity | | | | |
| Hyperechoic | 85.9 | 25 | 27.8 | 84 |
| Hypoechoic | 60.9 | 50 | 21.74 | 84.9 |

Abbreviations: NPV, negative predictive value; PPV, positive predictive value.

Values are presented as percentages.

Range: 14.33% to 31.56%.

**Discussion**

US is widely accepted as the most sensitive imaging modality for nodule detection and routine interval monitoring. US FNAB is the gold standard in identifying malignant nodules according to the ATA. According to the 2015 guidelines proposed by the ATA Guidelines Task Force on Pediatric Thyroid Cancer, pediatric cases should be classified on the extent of disease and stratified into risk levels according to the AJCC TNM system.

Abnormal-appearing lymph nodes, microcalcifications, irregular margins, larger size, solid composition, increased blood flow, and hypoechogenicity are commonly recognized US characteristics most predictive of malignancy in adults. However, there are varying reports of the predictability in US characteristics in pediatric patients.

In a study evaluating 404 thyroid nodules (314 patients), Richman et al determined the criteria of the American College of Radiology’s TI-RADS to be inadequate in assessing the risk of pediatric thyroid nodules, as it would have missed 21% of malignant cases. A size criterion for the pediatric population, in which the thyroid volume changes as children grow, can be problematic. Varying accounts of predictability require a large study to understand and help standardize the most important guidelines for indeterminate nodules after US FNAB.

Our study supports accepted literature on the higher rate of malignant nodules in children (18%) than adults (5%-10%). It also supports literature on the predictive value of microcalcifications, abnormal lymph nodes, and size. However, irregular margins, hypoechogenic nodules, and vascularization did not prove to be statistically significant predictors in our study. A nodule with microcalcifications was 19 times more likely to be malignant than a nodule without microcalcifications. The presence of microcalcifications is the strongest predictor of malignancy and shows a specificity of 90% and a sensitivity of 70%.

Patients with abnormal lymph nodes are 9 times more likely to have malignant nodules. Nodules that were >3.5 cm in diameter were highly specific (95%) but not sensitive (25%) in predicting malignancy. Larger nodules were 5.8 times more likely to be malignant. Irregular borders were not statistically significant.

Ninety-four percent of the children in our study were Caucasian, and all malignant nodules were found in Caucasian children. Females are generally more likely to present with nodules. In our study 6 times as many females were likely to have malignant nodules when compared with their male counterparts. The incidence of thyroid nodules rises after females go through puberty; this is hypothesized to be an effect of estrogen.

All our patients with malignant nodules were >10 years old. The predilection for females to develop benign nodules proved significant, with a female: male ratio of 3.8:1. These demographic characteristics are consistent with previous literature.

Most patients who underwent US FNAB proved to have benign nodules (96/116, 82%). The abnormal characteristics found in malignant nodules—irregular margins, abnormal lymph nodes, and microcalcifications—were much less common with prevalences of 26%, 12%, and 11%, respectively. Over 95% of benign nodules were <3.5 cm in diameter.

With improvements in US technology, additional characteristics have been hypothesized and studied in pediatric thyroid nodules and lymph nodes. Ríos et al analyzed 221 pediatric thyroid nodules with US and elastography and reported 100% specificity in determining benign nodules. Elastography has recently risen as a noninvasive imaging technique for differentiating between benign and malignant nodules. A study by Ríos et al found elastography to be 96% sensitive and 98% specific in differentiating benign from malignant nodules. However, further research is needed to establish its role in the management of pediatric thyroid nodules.
modality to increase the specificity of US. Additionally, oncogene testing may prove useful in ruling out malignancy in nodules with indeterminate cytology. Oncogene testing has become popular and reliable in adult thyroid nodules that are indeterminate and have the potential to dramatically dictate treatment.

**Limitations**

Limitations of the study include bias inherent in case series with chart review. The study assessed patient nodules instead of simply total nodules. The overall sample size, as well as that of the malignant nodule group, was small. This diminished the power of the study and resulted in large confidence intervals. There was prominent interobserver variability between the radiologists who read the US as well as the multiple radiologists who performed each FNAB.

A subset of characteristics, such as vascularity, elastography, and echogenicity, was not always documented or was completely missing from US reports. Almost 95% of the participants were Caucasian at a single hospital system, thereby limiting the generalizability of the study to the general population. Although we aimed to look at the pathology of each nodule, the ability to sample all nodules in patients with multiple nodules may have been limited to those with dominant and incidental nodules.

Multiple nodules in a single patient were evaluated together. The most prominent nodule characteristics were taken, which may have skewed more positive findings among the patient population rather than true nodule findings. However, advantages include not associating all accompanying factors to all nodules when one may have been malignant while the others may have been benign.

**Conclusion**

Our data suggest that abnormal lymph nodes (as defined by the presence of calcifications, abnormally round shape, hyperechogenicity, and peripheral vascularity), microcalcifications, and size >3.5 cm could be predictors of malignancy in the pediatric population and influence clinical decision making. Future directions include collecting more data on pediatric malignant thyroid nodules, thereby increasing the power of the study.

**Author Contributions**

Brandon Fornwalt, study design, data collection, manuscript preparation (all portions), revisions; Manasa Melachuri, data collection, manuscript preparation (discussion), Matthew Kubina, data collection, statistics, manuscript preparation (results); Janice McDaniel, study design, manuscript review, ultrasound review; Anita Jeyakumar, study design, manuscript review, revisions, submission.

**Disclosures**

**Competing interests:** None.

**Sponsorships:** None.

**Funding source:** None.

**ORCID ID**

Anita Jeyakumar [https://orcid.org/0000-0002-8125-279X](https://orcid.org/0000-0002-8125-279X)

**References**

1. Dermody S, Walls A, Harley EH Jr. Pediatric thyroid cancer: an update from the SEER database 2007-2012. Int J Pediatr Otorhinolaryngol. 2016;89:121-126.

2. Essenmacher AC, Peter H, Joyce J, et al. Sonographic evaluation of pediatric thyroid nodules. Radiographics. 2017;37(6):1731-1752. doi:10.1148/rg.2017170059

3. Gupta A, Ly S, Castronoves LA, et al. A standardized assessment of thyroid nodules in children confirms higher cancer prevalence than in adults. J Clin Endocrinol Metab. 2013;98(8):3238-3245. doi:10.1210/jc.2013-1796

4. Richman DM, Benson CB, Doubilet PM, et al. Assessment of American College of Radiology Thyroid Imaging Reporting and Data System (TI-RADS) for pediatric thyroid nodules. Radiology. 2020;294(2):415-420. doi:10.1148/radiol.2019191326

5. Al Nofal A, Gionfriddo MR, Javed A, et al. Accuracy of thyroid nodule sonography for the detection of thyroid cancer in children: systematic review and meta-analysis. Clin Endocrinol (Oxf). 2016;84(3):423-430. doi:10.1111/cen.12786

6. Francis GL, Waguespack SG, Bauer AJ, et al. Management guidelines for children with thyroid nodules and differentiated thyroid cancer. Thyroid. 2015;25(7):716-759.

7. Richman DM, Benson CB, Doubilet PM, et al. Thyroid nodules in pediatric patients: sonographic characteristics and likelihood of cancer. Radiology. 2018;288(2):591-599. doi:10.1148/radiol.2018171170

8. Koltin D, O’Gorman CS, Murphy A, et al. Pediatric thyroid nodules: ultrasonographic characteristics and inter-observer variability in prediction of malignancy. J Pediatr Endocrinol Metab. 2016;29(7):789-794. doi:10.1515/jped-2015-0242

9. Jatana KR, Zimmerman D. Pediatric thyroid nodules and malignancy. Otolaryngol Clin North Am. 2015;48(1):47-58. doi:10.1016/j.otc.2014.09.005

10. Tamhane S, Gharib H. Thyroid nodule update on diagnosis and management. Clin Diabetes Endocrinol. 2016;2:17. doi:10.1186/s40842-016-0035-7

11. Iakovou I, Giannoula E, Sachpekidis C. Imaging and imaging-based management of pediatric thyroid nodules. J Clin Med. 2020;9(2):384. doi:10.3390/jcm9020384

12. Creo A, Alahdab F, Al Nofal A, Thomas K, Kolbe A, Pittock ST. Ultrasonography and the American Thyroid Association ultrasound-based risk stratification tool: utility in pediatric and adolescent thyroid nodules. Horm Res Paediatr. 2018;90(2):93-101. doi:10.1159/000490468

13. Mulder JE. Thyroid disease in women. Med Clin North Am. 1998;82(1):103-125. doi:10.1016/s0025-7153(05)70596-4

14. Li H, Li J. Thyroid disorders in women. Obes Clin Pract. 2018;151(3):89-96. doi:10.1016/j.ocl.2017.09.016

15. Rı´os A, Rodriquez JM, Torregrosa NM, et al. Evaluation of the thyroid nodule with high-resolution ultrasonography and elastography without fine needle aspiration biopsy. Med Clin (Barc). 2018;151(3):89-96. doi:10.1016/j.medcli.2017.09.016

16. Bauer AJ. Thyroid nodules in children and adolescents. Endocrinol Diabetes Obes. 2019;26(5):266-274. doi:10.1097/MED.0000000000000495