Ultrasonography in the Treatment of a Pediatric Midline Neck Mass

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Objective: To assess the effectiveness of ultrasonography for determining which pediatric midline neck masses should be treated surgically.

Design: Retrospective study.

Setting: Tertiary care pediatric hospital.

Patients: Pediatric patients with a midline neck mass who underwent ultrasonography from 2003 to 2011.

Main Outcome Measures: Demographics, ultrasonography, and surgical and pathology reports were studied. The ultrasonography findings and pathological analyses were compared.

Results: One hundred twenty-two patients met the inclusion criteria. The most common diagnosis obtained by ultrasonography was thyroglossal duct cyst (48.4%), followed by reactive lymph node (27.9%). Ninety-five of 122 patients (77.9%) underwent surgery. Twenty-seven patients (22.1%) were treated nonsurgically. The diagnosis and characteristics obtained from ultrasonography were confirmed by surgical pathologic analysis in 84.2% of the surgical cases. Of the 95 patients who underwent surgery, 85 (89.5%) had a non–lymph node lesion diagnosed by ultrasonography and confirmed by pathologic analysis. Ultrasonography was only 66.1% accurate in specifically diagnosing thyroglossal duct cyst and 30.0% accurate in specifically diagnosing reactive lymph node when compared with surgical specimens.

Conclusions: Ultrasonography is helpful in determining the pediatric midline neck masses that need to be removed surgically. It is less helpful in determining the exact pathologic characteristics of the lesion.


Midline neck masses are commonly seen in the pediatric population. The differential diagnosis of a midline neck mass includes thyroglossal duct cyst (TGDC), reactive lymph node (RLN), dermoid cyst, and ectopic thyroid. The most common etiology is the TGDC. The treatment of choice for a TGDC is surgical resection using the Sistrunk procedure. Both the TGDC and the dermoid cyst are treated by surgical resection. If the preoperative diagnosis of the neck mass is consistent with an RLN, medical treatment may be best. Ectopic thyroid refers to the presence of thyroid tissue in locations other than the normal anterior neck region. Ectopic thyroid tissue may become goitrous and can be associated with thyroid dysfunction. Rarely, benign or malignant neoplastic changes can occur in ectopic thyroid tissue. Case reports describe submandibular or lateral ectopic thyroid tissue in the presence of a normal thyroid in adults. Ectopic thyroid tissue is the cause of the midline neck mass 1% to 2% of the time, and inadvertent removal of ectopic thyroid tissue may result in hypothyroidism. Therefore, preoperative investigation to determine the diagnosis of the pediatric midline neck mass and the location of the thyroid gland is crucial before undertaking surgical excision. Ultrasonography (USG) is often used to make this distinction.

Many studies evaluating the use of USG in the workup of a pediatric midline neck mass have been published. According to Sidell and Shapiro, the diagnostic accuracy of USG for diagnosing midline neck mass in pediatric patients is limited. They did not demonstrate an association between preoperative USG diagnoses (TGDC vs non-TGDC) and the surgical pathologic findings. In our study, we assessed the use of USG in the treatment of a pediatric midline neck mass. We emphasized the ability of USG to determine which masses should be treated surgically. We compared the USG diag-
nosity with the surgical pathologic findings in pediatric patients.

## METHODS

This retrospective study was conducted at Ann & Robert H. Lurie Children’s Hospital of Chicago, a tertiary care pediatric hospital in Chicago, Illinois. The institutional review board at Lurie Children’s Hospital approved the study. The medical records of those patients who were clinically diagnosed as having a midline neck mass and underwent USG from February 2003 to July 2011 were studied. All patients were younger than 18 years. Demographics, USG diagnosis and image characteristics, details from the operative report, and surgical diagnosis and surgical pathologic diagnosis were collected from the medical record. Progress notes from follow-up visits were reviewed.

The USG diagnosis was compared with the surgical pathologic diagnosis in 95 patients and was defined as follows:

- **Same**: If the USG diagnosis and surgical pathologic diagnosis were exactly same. Example: the USG diagnosis and surgical pathologic diagnosis was TGDC.
- **Consistent**: If USG diagnosis and surgical pathologic diagnosis were not exactly the same but the USG diagnosis and the surgical pathologic diagnosis were both a non-LN lesion. Example: If the USG diagnosis was dermoid cyst and the surgical pathologic diagnosis was TGDC. Despite the different diagnoses, the treatment was the same, ie, surgery.
- **Not same**: If USG diagnosis and surgical pathologic diagnosis were not the same and the treatment obtained from USG diagnosis was also not the same as that for the surgical pathologic diagnosis. Example: If the USG diagnosis was dermoid cyst but the surgical pathologic diagnosis was an RLN. In this case, the USG diagnosis influenced the decision for surgical treatment, but the patient could have been treated by clinical follow-up and observation.
- **Not applicable (NA)**: If USG diagnosis was uncertain. In that situation, no specific USG diagnosis was available to compare the findings with the surgical pathologic analysis.

The accuracy of USG for specifically diagnosing TGDC and RLNs was evaluated by comparing USG diagnosis with surgical pathologic analysis. Data were stored in an Excel spreadsheet (Microsoft). Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated according to standard formulas mentioned elsewhere. Data are expressed as numbers (percentages). We used SPSS software (version 14) for statistical analysis.

### RESULTS

Two hundred ninety-eight pediatric patients underwent USG of a neck mass and were evaluated for this study. One hundred seventy-six patients were excluded because either the masses were not in the midline neck (n=149) or the patients were lost to follow-up (n=27). One hundred twenty-two patients who had a midline neck mass and who underwent USG were included in the analysis. There were 63 male (51.6%) and 59 female (48.4%) patients with a mean age of 5.41 years (range, 0.24-17.5 years). Ninety-five of 122 patients (77.9%) underwent surgery, and 27 of 122 patients (22.1%) were treated by clinical follow-up alone. Twenty-four of 27 patients (88.9%) followed nonsurgically were diagnosed as having an RLN based on the USG findings. One patient was diagnosed as having an ectopic thyroid, 1 as having a hemangioma, and 1 had an uncertain diagnosis on USG but was eventually diagnosed as having an RLN.

The most common preoperative diagnosis obtained by USG was TGDC [59 of 122 patients (48.4%)] followed by RLNs [34 of 122 patients (27.9%)]. There was 1 patient diagnosed as having an ectopic thyroid and 1 patient diagnosed as having hemangioma. Both were treated nonsurgically (Table 1). In the 95 patients who underwent surgery, the USG diagnosis was compared with the surgical pathologic analysis. In 42 of 95 patients (44.2%), the USG diagnoses were categorized as “same” and in 38 of 95 patients (40.0%) were categorized as “consistent.” In 8 of 95 patients (8.4%) the USG diagnoses were categorized as “NA” and in 7 of 95 patients (7.4%) were categorized as “not same.”

In the 95 patients who underwent surgery, the overall PPV of USG compared with surgical pathologic analysis was 44.2% (42 of 95 patients). The PPV for USG diagnosis of TGDC was 66.1% (39 of 59 patients), and the most common pathologic finding that mimicked TGDC on USG diagnosis was dermoid cyst in 28.8% patients (17 of 59), followed by epidermal inclusion cyst in 3 of 59 patients (5.1%). The PPV for USG diagnosis with RLNs was 30.0% (3 of 10 patients) (Table 2).

Thyroglossal duct cyst was the most common lesion diagnosed by USG. We compared all the masses identified as a TGDC on USG with their eventual surgical pathologic analysis. The sensitivity and the specificity of USG in diagnosing a TGDC were 67.2% and 45.9%, respectively. The PPV was 66.1%, and the NPV was 47.2% (Table 3). In the 34 patients who were diagnosed as having an RLN by USG (27.9% of 122 patients), only 10 (29.4%) underwent surgical excision. These lesions were excised because the clinical characteristics of the masses were not consistent with those of an RLN. Of these 10 patients, 4 (40.0%) underwent computed tomography (CT) or magnetic resonance imaging (MRI); the results did not support the USG diagnosis, and the lesions were excised. Two patients (20.0%) had findings from a physical examination that were consistent with TGDC. One patient (10.0%) had a recurrent mass, and the mass was excised. In this case, the surgical pathologic diagnosis was consistent with a TGDC. Three patients (30.0%) had masses that were larger than 2 cm and did not respond...
to the antibiotics, were removed, and were consistent with RLNs. Overall, for these 10 patients, the surgical pathologic diagnosis was an RLN in 3 patients (30.0%) and a TGDC in 7 patients (70.0%) (Table 2 and Table 3).

Table 2. Ultrasonography (USG) Diagnosis, Surgical Pathologic Diagnosis, and Positive Predictive Value

<table>
<thead>
<tr>
<th>USG Diagnosis</th>
<th>Surgical Pathologic Diagnosis, Patients, No./Total No. (%)</th>
<th>PPV, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>TGDC</td>
<td>TGDC=39/59 (66.1) Non-TGDC=20/59 (33.9) (Dermoid cyst=17, epidermal inclusion cyst=5)</td>
<td>66.1</td>
</tr>
<tr>
<td>RLN</td>
<td>RLN=3/10 (30.0) Non-LN (all TGDC)=7/10 (70.0)</td>
<td>30.0a</td>
</tr>
<tr>
<td>Dermoid cyst</td>
<td>Dermoid cyst=0/1 (0) Pilomatrixoma=1/1 (100)</td>
<td>0</td>
</tr>
<tr>
<td>Others</td>
<td>Dermoid cyst=10/21 (47.6) TGDC=10/21 (47.6) Epidermal inclusion cyst=1/21 (4.8)</td>
<td>0</td>
</tr>
<tr>
<td>Uncertain</td>
<td>TGDC=2/4 (50.0) Dermoid cyst=2/4 (50.0)</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>95 (100)</td>
<td>44.2</td>
</tr>
</tbody>
</table>

Table 3 demonstrates findings from the 95 patients who underwent surgery divided into 2 categories based on surgical pathologic diagnosis: those diagnosed as having an RLN vs those diagnosed as having a non-LN mass. Only 10 of 95 patients (10.5%) were diagnosed as having an RLN by USG, and the surgical pathologic diagnosis was consistent with an RLN in 3 of 10 patients (30.0%) and was consistent with TGDC in 70 of 10 patients (70.0%). Eight-five patients (85.0%) were diagnosed as having a non-LN by USG, and the surgical pathologic diagnosis was consistent with a non-LN in all of these patients. Sensitivity and specificity of USG in diagnosing RLNs were 100% and 92.4%, respectively. The PPV and NPV were 30% and 100%, respectively.

Preoperative investigation of a pediatric midline neck mass is required for 2 reasons: to determine whether surgical or nonsurgical treatment is most appropriate and to identify the position of the thyroid gland to help rule out ectopic thyroid. Ultrasonography is effective for this purpose; it is cost-effective, noninvasive, does not expose the patient to radiation, and often does not require sedation.1,2,14,17,18 It can also be used to follow progression of lesions before and after treatment.5

Table 3. Comparison of Ultrasonography Diagnosis (USG Dx) With Surgical Pathologic Diagnosis (Patho Dx) a

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Surgical Patho Dx, TGDC</th>
<th>Surgical Patho Dx, Non-TGDC</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>TGDC vs non-TGDC</td>
<td>58</td>
<td>59</td>
<td>117</td>
</tr>
<tr>
<td>USG Dx TGDC</td>
<td>39</td>
<td>20</td>
<td>59</td>
</tr>
<tr>
<td>USG DX non-TGDC</td>
<td>19</td>
<td>17</td>
<td>36</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>95</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Patho Dx, LN</th>
<th>Patho Dx, Non-LN</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLN vs non-LN</td>
<td>3</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>USG Dx RLN</td>
<td>0</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td>USG Dx non-LN</td>
<td>0</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>92</td>
<td>95</td>
</tr>
</tbody>
</table>

Abbreviations: LN, lymph node; PPV, positive predictive value; RLN, reactive lymph node; TGDC, thyroglossal duct cyst.

a The PPV of USG in patients diagnosed as having an RLN would increase to 79.4% (27 of 34 patients) if 24 patients diagnosed as having an RLN by USG and treated nonsurgically were assumed to have correct USG diagnosis.

Table 3 demonstrates findings from the 95 patients who underwent surgery divided into 2 categories based on surgical pathologic diagnosis: those diagnosed as having an RLN vs those diagnosed as having a non-LN mass. Only 10 of 95 patients (10.5%) were diagnosed as having an RLN by USG, and the surgical pathologic diagnosis was consistent with an RLN in 3 of 10 patients (30.0%) and was consistent with TGDC in 70 of 10 patients (70.0%). Eight-five patients (85.0%) were diagnosed as having a non-LN by USG, and the surgical pathologic diagnosis was consistent with a non-LN in all of these patients. Sensitivity and specificity of USG in diagnosing RLNs were 100% and 92.4%, respectively. The PPV and NPV were 30% and 100%, respectively.

Comment

Preoperative investigation of a pediatric midline neck mass is required for 2 reasons: to determine whether surgical or nonsurgical treatment is most appropriate and to identify the position of the thyroid gland to help rule out ectopic thyroid. Ultrasonography is effective for this purpose; it is cost-effective, noninvasive, does not expose the patient to radiation, and often does not require sedation.1,2,14,17,18 It can also be used to follow progression of lesions before and after treatment.5

The typical appearance of a TGDC on USG is a well-defined, thin-walled, anechoic or hypoechoic mass with posterior acoustic enhancement in the midline of the anterior neck (Figure 1).1,19 The typical USG finding of a dermoid is a complex cystic mass.1 A dermoid may also

Figure 1. Ultrasonographic images. A, The typical appearance of a thyroglossal duct cyst on an ultrasonographic image is a well-defined, thin-walled, anechoic or hypoechoic mass with posterior acoustic enhancement in the midline of the anterior neck (arrows). B, The thyroid gland is identified and appears normal (arrow).
exhibit pseudosolid appearance owing to the presence of cellular material within the cyst (Figure 2).20 The typical ultrasonographic findings of a reactive lymph node is a well-defined, elliptical structure with a hypoechoic halo and central linear hyperechoic fatty hilum (arrows) in which color Doppler demonstrates blood flow (arrows).

The accuracy, and therefore the utility of USG in the diagnosis of a pediatric midline neck mass, is controversial. Sidell and Shapiro15 failed to demonstrate an association between preoperative USG-based diagnoses of midline neck masses and surgical pathologic diagnosis. In that study, the sensitivity and specificity of USG in diagnosing TGDC were 80% and 20%, respectively. Both PPV and NPV were 50%. In another retrospective study based on a small number of patients, Huoh et al21 determined that neither MRI nor CT were more accurate in the diagnosis of TGDC than USG, and hence they do not confer a significant advantage over USG. In our study, the accuracy of USG in preoperatively diagnosing TGDC was 66.1%. The sensitivity and specificity of USG in diagnosing TGDC were 67.2% and 45.9%, respectively. The PPV and NPV in our study were 66.1% and 47.2%, respectively (Table 2). Although the specificity and PPV of USG in diagnosing TGDC in our study were slightly higher than those in the study by Sidell and Shapiro,15 the results were similar and relatively low. As described in Table 2, a dermoid cyst was the most common lesion that mimicked TGDC on USG. Therefore, when a TGDC is diagnosed by USG, a dermoid cyst should still be considered in the differential diagnosis, and the surgical plan may depend on intraoperative findings and intraoperative pathologic findings.

We evaluated the effectiveness of USG in a different way. We compared the preoperative USG diagnosis and characteristics with the postoperative surgical pathologic diagnosis and the ultimate treatment of each patient. Of the 95 patients evaluated, 42 (44.2%) were categorized as “same” and 38 (40.0%) as “consistent” (Table 4). Thus, when these 2 groups are combined, we determined that the information obtained from the USG led to the correct treatment of the midline neck mass in 80 of 95 of these patients (84.2%). Therefore, USG was very helpful in determining the correct treatment of the midline neck mass seen in these children.

The PPV of USG for correctly diagnosing an RLN in this study was 30% (Table 2). This number is low. However, the PPV could be calculated only in the patients who were diagnosed as having an RLN on USG and eventually had surgical excision. There were only 10 patients in this group. These 10 patients were diagnosed as having an RLN but were recommended for surgery because the masses did not respond to nonsurgical treatment. In these cases, additional clinical and radiologic information was suggestive that the mass was a TGDC. The other 24 of 34 patients (70.6%) who were diagnosed as having
an RLN by USG were treated nonsurgical excision. There was no surgical pathologic analysis performed in these patients to test the accuracy of the USG diagnosis. However, if the diagnoses obtained from the USG were correct in all of these 24, the PPV of USG for accurately diagnosing an RLN would increase to 79.4% (or 27 of 34 patients) (Table 2). It should be noted that all 24 of these patients had resolution of their neck mass with no recurrence after at least 1 year of follow-up. We conclude that when an RLN is diagnosed by USG, the physician should continue to monitor the mass and treat it with surgical excision only if the clinical picture warrants.

The incidence of ectopic thyroid according to the literature is 1% to 2%. In this study, 1 of the 122 patients studied (0.82%) was diagnosed as having an ectopic thyroid, for which surgical excision is contraindicated. We advocate using preoperative USG to identify the thyroid gland to prevent the inadvertent removal of the only functioning thyroid tissue.2,17,22 Figure 4 shows the algorithm that we propose for the treatment of pediatric midline neck masses.

In summary, pediatric patients with a midline neck mass should be investigated by USG to determine whether the mass is a non-LN lesion, which requires surgical excision, or an RLN lesion, which can be treated by watchful waiting. If the RLN demonstrates abnormal clinical or radiologic findings despite treatment, it can be excised as indicated. In addition, preoperative USG is essential to exclude ectopic thyroid before undergoing surgical excision.

In conclusion, USG is useful for the diagnostic workup of a pediatric midline neck mass. In our study, USG was found to be 84.2% accurate in determining which midline neck masses should be removed. However, USG is less reliable in determining the specific pathologic characteristics of the lesion: it was only 66.1% accurate in diagnosing TGDC and 30% accurate in diagnosing RLNs when the mass did not have characteristics consistent with an RLN. When an USG determines that the etiology of a pediatric midline neck mass is an RLN, continued clinical follow-up and possibly more diagnostic studies may be needed.

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 Author Contributions: All authors had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Tanphaichitr, Bhushan, Maddalozzo, and Schroeder. Acquisition of data: Tanphaichitr and Bhushan. Analysis and interpretation of data: Tanphaichitr, Bhushan, and Schroeder. Drafting of the manuscript: Tanphaichitr, Bhushan, and Maddalozzo. Critical revision of the manuscript for important intellectual content: Tanphaichitr and Schroeder. Statistical analysis: Tanphaichitr and Bhushan. Administrative, technical, and material support: Tanphaichitr, Bhushan, Maddalozzo, and Schroeder. Study supervision: Bhushan, Maddalozzo, and Schroeder.

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 REFERENCES