The Significance of Incidental Thyroid Abnormalities Identified During Carotid Duplex Ultrasonography

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**Hypothesis:** Incidental thyroid masses identified during carotid duplex ultrasonography may represent clinically significant lesions.

**Design and Setting:** Retrospective review of a prospective database in a tertiary care referral center.

**Patients:** A total of 2004 consecutive patients from January, 2000, through January, 2002, undergoing carotid duplex ultrasonography.

**Interventions:** After bilateral carotid duplex ultrasonography, selected patients additionally underwent 1 or more of the following: dedicated thyroid ultrasound, fine-needle aspiration biopsy, and/or partial or total thyroidectomy.

**Main Outcome Measures:** The prevalence and type of thyroid abnormalities, correlation with a dedicated thyroid ultrasound, and results of histopathologic diagnosis.

**Results:** One or more thyroid abnormalities were identified in 188 duplexes (9.4%) involving 168 patients. Abnormalities were unilateral in 84 patients (50.6%) and bilateral in 81 patients (49.4%). Seventy-seven abnormalities (47%) were cystic, 72 (43%) were solid, and 16 (10%) were of mixed consistency. Sixty-six of the patients (40%) went on to have formal thyroid ultrasounds. Forty-five patients (70.3%) had masses greater than 1 cm on ultrasound. Based on ultrasound findings, 29 of 66 (44%) underwent fine-needle aspiration biopsy, with 13 of 66 (19.7%) eventually undergoing surgery. Surgical pathology included 5 patients with cancer (3 with papillary cancer, 2 with follicular cancer), 4 patients with a follicular adenoma, and 2 with lymphocytic thyroiditis. Two additional patients were discovered to have parathyroid adenomas following further workup and surgery. Thyroid abnormalities identified during carotid duplex ultrasonography correlated with formal ultrasound in 64 of 66 (97%) patients. Measurement of the thyroid mass by carotid duplex strongly correlated with measurement by formal thyroid ultrasound ($r=0.95, P<.001$). Two patients with unilateral masses noted on carotid duplex had a normal thyroid formal ultrasound.

**Conclusions:** Incidental thyroid abnormalities identified during carotid duplex ultrasound are common and contain clinically significant pathology. A multidisciplinary clinical pathway may facilitate the appropriate evaluation of these abnormalities.

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normals. Our institutional review board approved the protocol prior to study commencement. Exclusion criteria included patients with a known history of thyroid nodules or other thyroid disease. All patients had a baseline history and physical examination, screening for symptoms of hyperthyroidism or hypothyroidism, and bilateral arm blood pressures. Patients were then assessed initially with a bilateral carotid arterial duplex examination using the ATL 5000 duplex ultrasound with a 4 to 7 MHz linear array transducer (Bothell, Wash). Registered vascular technicians performed all carotid duplex examinations, which were interpreted by board-certified vascular surgeons. We characterized nodules by laterality, consistency (solid, cystic, or mixed), and size. All patients with nodules greater than or equal to 1 cm in size or unusual characteristics seen on screening carotid ultrasound examinations underwent dedicated thyroid ultrasonography to confirm the presence of disease. We then reviewed medical records for specific data including patient demographics, medical history, prior head or neck irradiation, prior thyroid laboratory or imaging results, and current status of any ongoing thyroid evaluation. Patients who underwent further thyroid imaging that included a dedicated thyroid ultrasound had these results compared with the findings on carotid duplex. We also reviewed the histopathologic results on those patients who went on to have fine-needle aspiration (FNA) biopsy and/or surgery.

Patients without any further evaluation following the initial carotid duplex ultrasound within the prior 6 months were classified as “lost to follow-up.” Those with shorter intervals or recent studies were defined as “ongoing evaluations.” Thyroid abnormalities were defined as any irregular-appearing thyroid glands or specific nodules as seen by the carotid duplex. The main outcome measures were the prevalence and type of thyroid abnormalities, correlation with a dedicated thyroid ultrasound, and result of histopathologic diagnosis.

Comparison between the size of thyroid nodules as identified by duplex and dedicated ultrasound was performed using Pearson correlation coefficient. Additional statistical analysis was carried out with a t test for continuous variables, and a χ² or Fisher exact test was used for nominal data when appropriate, with significance set at P≤.05.

This study consisted of 200+ consecutive patients undergoing carotid duplex ultrasonography over a 2-year period. We identified 1 or more thyroid abnormalities in 188 duplexes (9.4%) involving 168 patients. Three patients met our exclusion criteria, leaving 165 patients for analysis (Table 1). Sixty-eight patients were male (mean age, 68.4 years; range, 46-86) and 97 were female (mean age, 67.5 years; range, 40-84). Eighty-three percent of patients were white, with the remainder divided between African American (15%), Hispanic (1%), and Asian (1%). Hypertension was present in 103 of 165 patients (62%), and over 60% had a smoking history with an average of 25 pack-years, with only 10 patients actively smoking. Only 1 patient had a history of cervical irradiation (for Hodgkin disease). The thyroid masses were unilateral in 84 patients (50.6%) and bilateral in 81 (49.4%). Forty-seven percent were cystic, 43% were solid, and 10% were of mixed consistency. Palpable nodules made up 12.5%.

Sixty-six patients (40%) went on to have dedicated thyroid ultrasounds. All of these nodules had a solid component, were greater than or equal to 1 cm, and had an irregular appearance on duplex. Forty-five patients (70.3%) had masses greater than or equal to 1 cm on dedicated ultrasound. Small (<5-mm) purely cystic nodules were not sent for thyroid ultrasound. Based on ultrasound findings, 29 (44%) of 66 patients underwent FNA biopsy. Fifteen patients had benign pathology on FNA, 6 with follicular hyperplasia, 5 with indeterminate cytology, and 3 patients with cytology for malignancy.

Thirteen (19.7%) of the 66 patients who had dedicated thyroid ultrasounds underwent surgery. As shown in Table 2, final surgical pathologic findings included 4 patients with a follicular adenoma, 2 with lymphocytic thyroiditis (1 of which had been treated with radiation exposure), and 5 patients with thyroid carcinoma (3 with papillary cancer, and 2 with follicular cancer). Two additional patients were discovered to have parathyroid adenomas following further workup of the identified abnormality and surgery. There were no perioperative complications, and none of the patients died following surgery.

Sixty-four (97%) of 66 patients with thyroid abnormalities seen on screening carotid duplex ultrasound were confirmed by the extended thyroid sonographic examination. There were 2 patients with unilateral masses noted on carotid duplex that had a normal thyroid ultrasound

Table 1. Patient Demographics and Nodule Characteristics

<table>
<thead>
<tr>
<th>Variable (n = 165)</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age, y</td>
<td>67.8 ± 10.3</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>68 (41)</td>
</tr>
<tr>
<td>Female</td>
<td>97 (59)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>136 (83)</td>
</tr>
<tr>
<td>African American</td>
<td>25 (15)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>2 (1)</td>
</tr>
<tr>
<td>Asian</td>
<td>2 (1)</td>
</tr>
<tr>
<td>Nodule laterality</td>
<td></td>
</tr>
<tr>
<td>Unilateral abnormality</td>
<td>84 (51)</td>
</tr>
<tr>
<td>Bilateral abnormalities</td>
<td>81 (49)</td>
</tr>
<tr>
<td>Nodule composition on duplex</td>
<td>34 (21)</td>
</tr>
<tr>
<td>Cystic</td>
<td>77 (47)</td>
</tr>
<tr>
<td>Solid</td>
<td>72 (43)</td>
</tr>
<tr>
<td>Mixed</td>
<td>16 (10)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>103 (63)</td>
</tr>
<tr>
<td>Tobacco use</td>
<td>107 (65)</td>
</tr>
<tr>
<td>Prior neck irradiation</td>
<td>1 (&lt;1)</td>
</tr>
<tr>
<td>Palpable nodule</td>
<td>21 (12.5)</td>
</tr>
<tr>
<td>Thyroid nodule ≥1 cm</td>
<td>45 (27)</td>
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</table>

Table 2. Surgical Pathologic Findings

<table>
<thead>
<tr>
<th>Variable (n = 13)</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malignancy</td>
<td>5 (39)</td>
</tr>
<tr>
<td>Papillary cancer</td>
<td>3 (24)</td>
</tr>
<tr>
<td>Follicular cancer</td>
<td>2 (15)</td>
</tr>
<tr>
<td>Follicular adenoma</td>
<td>4 (31)</td>
</tr>
<tr>
<td>Lymphocytic thyroiditis</td>
<td>2 (15)</td>
</tr>
<tr>
<td>Parathyroid adenomas</td>
<td>2 (15)</td>
</tr>
</tbody>
</table>
Both of the patients with eventual parathyroid abnormalities were initially identified as having irregular-appearing thyroid glands with nodules. Additionally, measurement of the thyroid nodules by carotid duplex strongly correlated with measurement by formal thyroid ultrasound ($r = 0.95$, $P < 0.001$). Figure 1 and Figure 2 show comparison images of the 2 modalities for a papillary cancer.

Table 3 shows the status of the thyroid nodules identified by carotid duplex ultrasonography. Forty-three patients (26%) have ongoing evaluations to include a nuclear medicine scan, FNA biopsy, formal ultrasound, and/or are awaiting surgery. Forty patients (24.2%) have been lost to follow-up. In addition, 3 patients died during the follow-up period, none as a result of their thyroid nodules.

**COMMENT**

The manner in which a patient seeks care is only one aspect of any disease process. It is incumbent on the physician to evaluate all available information—whether it is a discovery on physical examination, laboratory abnormality, or radiographic finding—and know how to systematically care for the patient. The increasingly widespread use of radiologic imaging to improve diagnostic accuracy and specificity has had the secondary effect of creating an epidemic of incidentally found and usually asymptomatic lesions. The further evaluation and management of these so-called incidentalomas is an area of ongoing debate and presents a complex set of medical, economic, and legal dilemmas. Bailey and Aron have even outlined a 4-step process involving a formal decision analysis that may be considered in the diagnostic approach to any incidentaloma. As such, with increasing cervical imaging it has become as important to have an organized approach with thyroid lesions as with the adrenal incidentaloma recognized on abdominal computed tomographic scans performed for other reasons. Although many authors have written extensively about the approach to treatment for palpable or symptomatic thyroid nodules, disagreement remains about the appropriate evaluation and treatment of these incidental thyroid nodules.

Physical examination is historically poor at detecting thyroid nodules, their size, and malignant potential. Physicin inexperienced in interpreting what constitutes an abnormal gland, and patient factors such as a short, muscular...
and 13%, with a mean of 3.9%.\textsuperscript{1} Accounting for those occult thyroid cancers to be present anywhere between 0.5% and 50% of patients over 60 years old,\textsuperscript{19} we were initially concerned that we had underestimated the true prevalence in our cohort. Ideally, all 2004 patients would have undergone dedicated thyroid ultrasound testing to determine our true- and false-negative and positive rates. However, with our large sample size and the high correlation between both modalities in those patients undergoing both examinations, this number should be relatively accurate.

In terms of significant pathology, we did identify 5 patients with malignancy. This makes up 3% of all patients with nodules, and 7.6% of those patients undergoing dedicated ultrasound. Previous published reports have found occult thyroid cancers to be present anywhere between 0.5% and 13%, with a mean of 3.9%.\textsuperscript{1} Accounting for those patients lost to follow-up and those patients with obvious small or benign nodules seen on duplex that did not or may not have required dedicated thyroid ultrasound, our percentage may have actually been higher. It is important to emphasize that we are not recommending the use of cervical duplex ultrasound to be used as a screening tool, nor discussing the cost-benefit analysis of thyroid gland screening. Rather our data does show that clinically significant pathology may be present in observed incidental findings, and selected abnormalities need further investigation. Because of the proximity of the gland when performing a carotid duplex, the examiner is granted a “free look” at the thyroid gland. In no case were additional ultrasonographic windows taken to specifically look at the thyroid gland outside the normal parameters of the carotid duplex. The duplex is thus not meant to be used as a screening tool, but rather to enhance the physical examination and pick up lesions that may not otherwise be noted.

We were also able to detect 4 follicular adenomas, and 2 cases of parathyroid adenomas with previously undiagnosed primary hyperparathyroidism as a result of abnormalities seen on the duplex. Prior authors have described the use of either parathyroid or thyroid imaging to pick up pathology in the other gland(s), as well as the potential for coexistent pathology.\textsuperscript{20,22} This is not surprising given the embryological origin and anatomic location of the glands, and it serves to emphasize that some abnormalities do require further investigation.

A few authors have looked at the role of duplex ultrasonography in evaluating thyroid nodules. One study found duplex with doppler analysis of thyroid nodules was helpful in discriminating the majority of neoplastic from non-neoplastic lesions by identifying intranodular flow in malignant lesions vs avascular or halo-flow lesions only in colloid nodules.\textsuperscript{23} Yet increased vascularity seen on duplex ultrasonography can also be seen in benign conditions such as Graves disease\textsuperscript{24} and thyroiditis.\textsuperscript{25} Another study looked at the relationship of thyroid abnormalities and their role on duplex findings of the carotid vessels. Those authors concluded that differentiation among the types of thyroid nodule abnormalities was impossible.\textsuperscript{26} In the present study, we found a 100% correlation between the carotid duplex and dedicated ultrasound for nodule size, as well as a 97% rate of correlation with nodule appearance. Thus, our findings suggest instead that properly interpreted duplexes may potentially demonstrate which nodules have benign characteristics and which are more concerning. We do not suggest that patients should avoid undergoing a dedicated thyroid ultrasound. Like all studies of this imaging modality, duplex is operator dependent. Registered vascular technicians have no formal training in ultrasound of the thyroid region, and our high correlation rates may speak more to our technicians’ skills. Rather, thyroid imaging could be incorporated into registered vascular technician training if deemed cost-effective. Or perhaps nodules with a benign appearance meeting certain criteria such as size less than 1 cm, without irregular appearance, or purely cystic lesions identified on carotid duplex may not mandate a formal ultrasound. Nonetheless, prior to implementing these guidelines, a prospective study would need to be performed to address these questions.

It is also important to realize that this study does not address the natural history or benefits of intervention on incidental thyroid nodules identified by duplex in patients with vascular disease. Detractors may point out that patients with vascular disease tend to be older with multiple other medical problems. When this is coupled with thyroid cancer’s tendency to be a less morbid disease with high rates of long-term survival, one may question the indication for following up on these lesions at all. However, with advances in health care technology and an increasing emphasis in preventive medicine, we have seen a continuing trend toward a higher proportion of patients over the age of 70 years.\textsuperscript{27} Previous authors have shown that the prognosis for thyroid cancer in older patients is worse,\textsuperscript{28,29} possibly because of both the characteristics of the nodule itself (ie, vascular invasion and extension outside the gland)\textsuperscript{30} and surgeon hesitancy to operate on this patient population. Yet given this, most thyroid tumors have a higher rate of cure in the geriatric population.\textsuperscript{31} Because thyroid surgery has previously been shown to be safe and effective in older patients, even patients older than 75 years,\textsuperscript{12,33} it is important to identify these lesions and present the patient with a surgical option when indicated.

As a secondary outcome, we also wanted to perform a quality assurance evaluation on our health care system. We identified a surprisingly elevated level of patients characterized as lost to follow-up in this study. This is in part because of the unique nature of the clinical setting, with much of the patient population transferring to another area. We should point out that a predomiance of these patients who were lost to follow-up occurred in the early portion of the study period, prior to...
Thyroid Abnormality on Duplex Ultrasound

Serial Examinations

Thyroid Imaging

FNA
- Nodule >1 cm
- Prior Irradiation
- Family History of Medullary CA
- Rule Out Malignancy

Surgical Referral

History, Physical Examination, and Laboratory Evaluation

Long-term Follow-up

Appropriate patients will then be stratified to serial laboratory evaluation that includes thyroid function tests. Patients are sent for referral for general surgical evaluation. After a focused history and laboratory evaluation, patients are sent for referral for general surgical evaluation. After a focused history and physical examination, patients are sent for laboratory evaluation that includes thyroid function tests. Appropriate patients will then be stratified to serial examinations, further thyroid imaging, FNA biopsy, or surgery, with long-term follow-up as indicated.

CONCLUSIONS

Incidental thyroid abnormalities identified during carotid duplex ultrasound may contain clinically significant pathology and warrant follow-up evaluation when identified. In our population, 7.6% of those patients with concerning duplexes that went on to dedicated ultrasound ultimately had thyroid cancer. A clinical pathway to facilitate the appropriate evaluation of these thyroid abnormalities warrants prospective evaluation.

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REFERENCES


