

Ectopic Cervical Thyroid Carcinoma—Review of the Literature with Illustrative Case Series

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Context: More than 99% of thyroid cancers arise eutopically within the thyroid gland. The most frequent sites of ectopic thyroid tissue are lingual, sublingual, thyroglossal, laryngotracheal, and lateral cervical. Thyroid tissue can also be found in remote structures that were associated with the thyroid anlage during development, including the esophagus, mediastinum, heart, aorta, adrenal, pancreas, gallbladder, and skin. Ectopic thyroid tissue can be subject to the same pathological processes as normal eutopic thyroid tissue such as inflammation, hyperplasia, and tumorigenesis. The aim of this review is to describe aspects of thyroid cancer arising from the ectopic thyroid tissue in the neck in regard to epidemiology, diagnosis, and treatment and to present an illustrative series of cases of ectopic thyroid cancer.

Data Acquisition: We have searched the PubMed database for articles including the keywords “ectopic thyroid cancer” published between January 1, 1960, and January 1, 2011. As references, we used clinical case series, case reports, review articles, and practical guidelines focused on ectopic thyroid cancer confined to the neck region.

Synthesis and Conclusions: The possibility of an ectopic thyroid cancer should be considered in the differential diagnosis of a pathological mass in the neck. Treatment of ectopic cervical thyroid cancer is based predominantly on the surgical excision of the malignant lesion. Management strategies, including performance of total thyroidectomy, neck dissection, and treatment with radioiodine, should be based on individualized risk stratification. (*J Clin Endocrinol Metab* 96: 2684–2691, 2011)

More than 99% of thyroid cancers arise eutopically within the thyroid gland. Rare ectopic sites of origin of thyroid cancer include struma ovarii and other sites that are largely confined to the neck and reflect an aberrant embryological origin and location of thyroid tissue. The aim of this review is to describe aspects of thyroid cancer arising from ectopic thyroid tissue in the neck in regard to epidemiology, diagnosis, and treatment. A brief consideration of the embryological development of the thyroid provides insight into the genesis of these ectopic locations of thyroid cancer.

The thyroid gland develops as an endodermal diverticulum in the midline of the ventral pharynx between the first and second pharyngeal pouches. This invagination, located at the foramen cecum, descends ventrally and caudally toward the anterior neck and passes the developing hyoid bone to form most of the thyroid parenchyma. The gland initially remains attached to the foramen cecum by the thyroglossal duct, which then begins to atrophy in the seventh week. Failure of descent of either the medial anlage of the thyroid or the ultimobranchial bodies and the

incomplete obliteration of its vertical tract lead to ectopic thyroid development. Thyroid ectopy has a reported prevalence of approximately 1 in 10,000 (1, 2). However, it is likely that this is an underestimate because ectopic tissue is often found either incidentally during surgery or at autopsy (3, 4). The most frequent sites of ectopic thyroid tissue are lingual, sublingual, thyroglossal, laryngotracheal, and lateral cervical (1, 2). Thyroid tissue can also be found, albeit extremely rarely, in remote structures that were associated with the thyroid anlage during development, including the esophagus (5), mediastinum (6, 7), heart (8), aorta (9), adrenal (10), pancreas (11), gallbladder (12), and skin (13).

Ectopic thyroid tissue can be subject to the same pathological processes as normal eutopic thyroid tissue such as inflammation, hyperplasia, and tumorigenesis. Notably, regarding malignant lesions of the ectopic thyroid, it may be extremely difficult to distinguish primary neoplastic involvement of ectopic thyroid tissue from a cervical lymph node metastasis. This distinction constitutes a differential diagnosis of special importance in the management of patients with a history of thyroid malignancy.

Lingual Thyroid Cancer

Epidemiology and clinical presentation

Clinically apparent lingual thyroid is an unusual condition with approximately 400 cases reported in the literature (14). In 70% of these clinically evident or symptomatic cases, the lingual thyroid is the only functional thyroid tissue (15), and an inadequate functional tissue mass leads to hypothyroidism in one third of cases (16). However, postmortem studies indicate a higher prevalence of lingual thyroid, reaching up to as much as 10% of the general population (17, 18). Carcinoma arising in a lingual thyroid is extremely rare, with an estimated incidence of 1%, and often presents during the third decade of life (19, 20). Although papillary thyroid carcinoma (PTC) is by far the most common thyroid malignancy, there have been only 10 documented cases of PTC, with approximately 45 documented cases of follicular thyroid cancer (FTC), two cases of follicular variant of papillary carcinoma (19, 21–23), and one case of medullary thyroid cancer (24). How the natural history of lingual thyroid carcinoma differs from eutopic thyroid cancer remains largely unknown because of the rarity of the condition.

Treatment

In the majority of reported cases of lingual thyroid carcinoma, the carcinoma did not extend beyond the tongue. Regional lymph node involvement has been documented

in 21% of patients, with distant metastases confined to the lungs or mediastinum in 14% of patients (19). Surgical excision with wide margins is generally recommended as first-line therapy. In the vast majority of reported cases, the tumors have been excised via the transoral route because this technique is both simpler and more cost-effective (25). Recently, Terris *et al.* (26) described a minimally invasive transoral procedure that incorporates harmonic technology and high-resolution endoscopy and can be accomplished on an outpatient basis. However, in the case of a large mass that extends deep into the tongue, an external approach including a transhyoid incision and lateral pharyngotomy is generally indicated (27). Regardless of the surgical approach, severe postoperative edema is frequently experienced, making temporary tracheostomy mandatory in most cases. A neck dissection would only be indicated if additional lesions or metastatic-appearing nodules are noted or suspected (28). With tumor extension beyond the surgical margins or more advanced disease, adjunctive high-dose ¹³¹I ablation is indicated (29). Although this recommendation is based on a very limited number of patients, no disease progression was reported in the two cases reviewed in which positive margins were identified and radioactive iodine was subsequently administered (29, 30). Treatment with ¹³¹I alone is also an option for patients who are poor surgical candidates or who decline surgical intervention. Radioactive iodine ablation was used in three prior cases and resulted in reduction in tumor size, resolution of symptoms, and absence of disease progression in two of the patients (31, 32), and transient benefit was followed by the tumor enlargement in the remaining patient (19). All patients should receive levothyroxine therapy to suppress secretion of TSH. There are no data regarding the optimal long-term follow-up strategy of this group of patients, and we presume that a program of surveillance for recurrence as would be done for FTC or PTC is warranted.

Cancer of the Thyroglossal Duct Cyst (TGDC)

Epidemiology and clinical presentation

TGDC are the most common developmental anomalies of the thyroid gland. They comprise 75% of midline neck tumors in children and 7% in adults (33). Carcinoma of the thyroglossal duct remnant is reported in less than 1% of patients with TGDC (28, 34). Confirmation of the diagnosis of a TGDC is established by pathological examination with demonstration of an epithelial lining of the duct or cyst with normal thyroid follicles in its wall. Consistently, malignancies of the thyroglossal duct are

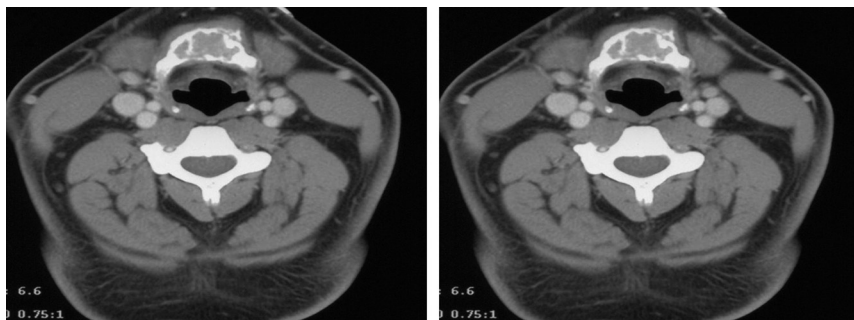


FIG. 1. TGDC carcinoma presenting as a lytic lesion of the hyoid bone.

either squamous cell carcinoma or thyroid cancer. The distinction between thyroglossal duct remnant cancer and pyramidal lobe tumors requires specific pathological criteria, as pointed out by LiVolsi *et al.* (20). These criteria were established by Joseph and Komorowski (35) for the diagnosis of a primary thyroglossal duct carcinoma as opposed to lymph node metastases from a primary thyroid carcinoma.

The reported histopathology of these tumors includes PTC in 80% of cases, follicular variant of PTC in 8%, and squamous cell cancer in 6%, and the remaining 6% includes FTC, Hurthle cell, and anaplastic cancer (28, 36–38). We could find no cases of medullary thyroid cancer in a TGDC reported in the literature. TGDC cancer usually presents between the ages of 20 and 50 yr and, like most thyroid cancers, affects women more commonly than men (28). TGDC cancer is rarely diagnosed before surgery and often presents as a benign TGDC. However, there are clinical features that should make one more suspicious for TGDC cancer. This concern is warranted in any midline cyst superior to the thyroid cartilage that is hard, fixed, irregular, or associated with lymphadenopathy. When these features are present and/or there is concern for malignancy preoperatively, fine-needle aspiration (FNA) or imaging may assist in making the diagnosis. FNA cytology of thyroglossal duct carcinoma has a true-positive rate of 53% and a false-negative rate of 47% (39). This high false-negative rate might be explained by the fact that the cystic fluid is often the initial specimen obtained during the FNA biopsy of TGDC, and hypocellularity is responsible for the lack of the appropriate diagnosis. Therefore, it is important to repeat the procedure and aspirate any residual solid regions after the cyst has been decompressed.

Imaging in the form of computerized tomography (CT) may reveal certain characteristics associated with malignancy. Of the 19 cases of TGDC with preoperative CT scans reported in the literature, findings suggestive of malignancy include dense or enhancing mural nodules, calcification, an irregular margin, or a thickened cyst wall

(40). The following summaries of three patients are illustrative of the presentation of thyroglossal duct carcinoma.

Case 1

A 35-yr-old man presented to our clinic with a 1-month history of an enlarging midline neck mass. CT scan revealed a lytic lesion of the hyoid bone (Fig. 1). No other neck masses were noted on imaging or physical examination, and the thyroid gland was normal. A FNA of the neck mass revealed PTC.

The patient underwent a Sistrunk procedure and a total thyroidectomy. Pathological examination revealed a 2-cm PTC within a TGDC involving the hyoid bone. The thyroid specimen also showed three foci of PTC, with the largest measuring 0.4 cm. Postoperatively, the patient was treated with 140.1 mCi of radioactive iodine, administered after preparation with thyroid hormone withdrawal, resulting in a serum TSH at the time of ablation of 120 mIU/liter. The posttreatment scan revealed ¹³¹I uptake confined to the thyroid bed. He remains free of disease 3 yr postoperatively with a negative neck ultrasound, undetectable suppressed and stimulated thyroglobulin levels, and negative recombinant human TSH-stimulated ¹²³I whole body scan performed 1 and 2 yr after the surgery.

Case 2

A 53-yr-old man presented to the otolaryngology clinic with an anterior neck mass present for 3 months. Physical examination revealed a 2-cm neck mass superior to the thyroid cartilage. A CT scan showed a cystic-solid mass immediately anterior to the hyoid bone with calcifications (Fig. 2), but no abnormalities of the thyroid gland. FNA showed atypical cells with large hyperchromatic nuclei and nuclear grooves. The patient underwent a Sistrunk procedure and a total thyroidectomy. The pathology showed a 1.6-cm PTC within a TGDC. The thyroid specimen showed multifocal PTC with the largest focus being 1 cm. Postoperatively, the patient was treated with 175.1 mCi of ¹³¹I, administered after preparation with thyroid hormone withdrawal resulting in the TSH elevation up to 57.3 mIU/liter. The posttreatment scan revealed radioiodine uptake in the thyroid bed and in a left supraclavicular lymph node. Follow-up diagnostic ¹²³I radioiodine scans at 1 and 2 yr showed interval resolution. However, the patient presented with residual locoregional disease as indicated by persistent detectable thyroglobulin levels ranging from 4.4–7.1 ng/ml while TSH suppressed and from 24.0–36.9 ng/ml after recombinant human TSH stimulation. FNA cytology of a cervical lymph node was

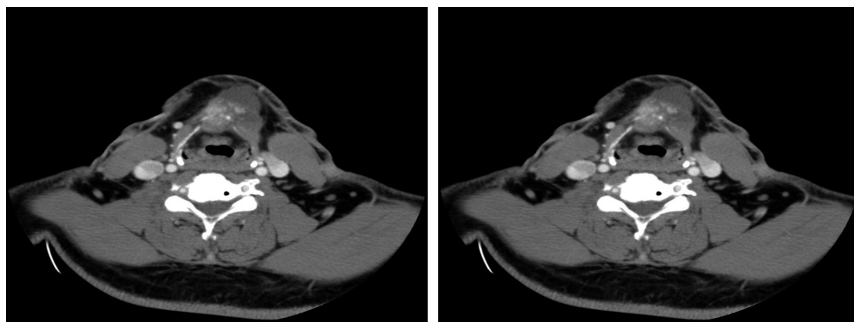


FIG. 2. TGDC carcinoma presenting as a cystic-solid mass anterior to the hyoid bone with calcifications.

positive for tumor. Three years after the initial surgery, the patient underwent a bilateral modified neck dissection. Pathological examination confirmed PTC in three of 69 lymph nodes.

Case 3

A 39-yr-old man presented to an outside hospital with a sore throat. His physician found a soft, mobile, 1-cm anterior neck mass. No thyroid abnormalities or cervical lymphadenopathy were noted on physical exam. A presumptive diagnosis of a TGDC was made, and the patient underwent excision of the cyst without excision of the central portion of the hyoid bone. Histological evaluation revealed PTC within the TGDC. The patient was started on levothyroxine therapy and was followed without evidence of recurrence for 6 yr. He was subsequently lost to follow-up.

Treatment

Definitive treatment for a TGDC carcinoma requires removal of the cyst along with the central portion of the hyoid bone, known as the Sistrunk procedure (34). In a retrospective review of 62 patients with TGDC cancer, the only significant predictor of outcome was the extent of surgery. Those patients with simple excision had a 75% 10-yr survival rate, whereas those undergoing a Sistrunk procedure had a 100% 10-yr survival rate (41). Although patient 3 in our series did not undergo a Sistrunk procedure and had a favorable outcome, we recommend a Sistrunk procedure for the surgical management of this disease based on the latter report. Additional approaches to treatment are more controversial and relate to varying concepts of the origin of thyroglossal duct carcinoma. Some argue that these lesions arise *de novo* within the cyst, whereas others believe the tumor represents a metastasis from an occult primary carcinoma of the thyroid gland. Two arguments support the *de novo* hypothesis. First, ectopic thyroid nests are present in as many as 62% of thyroglossal duct surgical specimens (42); secondly, para-follicular cells are absent in ectopic thyroid tissue, and we

could find no cases of medullary carcinoma of a thyroglossal duct. However, the finding of unsuspected carcinoma of the thyroid gland in 11–33% of patients with a TGDC who underwent thyroidectomy provides support for the metastatic theory (43). These percentages may be somewhat misleading, however, because not all patients with TGDC cancer undergo a thyroidectomy. The surgeon's decision to remove the thyroid gland depends on whether one believes TGDC cancer is a *de novo* process

or whether it represents a metastasis from carcinoma within the thyroid gland. This decision is also dependent on the adjunctive treatment plans, *i.e.*, whether subsequent treatment with radioiodine for metastatic disease is required. In such cases, a total thyroidectomy is warranted to facilitate further therapy. The 33% rate of unsuspected carcinoma in the thyroid in patients with TGDC cancer is consistent with the incidence of occult thyroid carcinoma found in autopsy studies of undiagnosed patients, suggesting that these lesions are not the source of carcinoma within the thyroglossal duct (44). It would appear that for patients with TGDC cancer and a concurrent suspicious thyroid lesion, total thyroidectomy clearly is warranted. However, an analysis by Patel *et al.* (41) indicated that the addition of a total thyroidectomy to a Sistrunk procedure in patients without a clinically or radiologically suspicious thyroid lesion did not have a significant impact on outcome. It should be noted that both patients in our series who underwent total thyroidectomy had multifocal PTC within the thyroid gland. We recommend that evaluation of the thyroid gland include palpation and a thyroid sonogram with appropriate management of any nodules so identified (45).

There are scant data on which to base the treatment of cervical lymph node metastases from TGDC cancer. In a study focused on 18 patients with PTC arising in a TGDC, Hartl *et al.* (46) documented that among 16 patients who underwent neck dissection of the central and/or lateral compartments, 12 (75%) presented with lymph node metastases. Nodes were positive in six of 15 central compartment dissections (40%) and in nine of 15 lateral neck dissections (60%). In their series, tumor foci were found in the thyroid in 56% of patients, and radioiodine for thyroid ablation was administered to 12 patients. After a median follow-up of 12 yr (range, 1–22 yr), a complete response with negative neck ultrasound and undetectable stimulated serum thyroglobulin levels was observed in 10 patients. This observation suggests that despite a high rate of the involvement of the thyroid and

lymph node metastases, the long-term outcome is excellent. Plaza *et al.* (47) proposed an algorithm for treatment of PTC in TGDC, with a simple Sistrunk procedure for patients less than 45 yr of age with tumors less than 1.5 cm confined to the cyst and an ultrasonographically normal thyroid gland with no suspicious lymph nodes. A total thyroidectomy would be done (with compartment-oriented neck dissection only if lymph node metastases are found on ultrasound or during surgery), followed by radioiodine for those not meeting these criteria. A slightly different approach is recommended by Patel *et al.* (41), who examined specific patient characteristics and sought to stratify them into “low risk” and “high risk.” A patient younger than 45 yr with a tumor less than 4 cm in size without soft tissue extension and without distant metastases and a clinically and radiologically normal thyroid gland is considered “low risk” and can be treated with the Sistrunk procedure alone (41, 48). Those in a higher risk group (older than 45, tumor larger than 4 cm, with soft tissue extension, with nodal or distant metastases) require more aggressive treatment, including Sistrunk procedure, total thyroidectomy with or without neck dissection, followed by radioactive iodine therapy. However, the small sample size may make any risk group stratification inaccurate. We recommend that specific consideration be given to each individual patient.

It is also difficult to know how to best approach the follow-up strategy in patients with TGDC. We would concur with recommendations for T₄ suppression therapy and periodic monitoring of serum thyroglobulin levels, but there is little evidence showing improved outcomes.

No patients with PTC of TGDC reviewed by Patel *et al.* (41) exhibited disease-related deaths over a 10-yr period, suggesting that TGDC PTC has an excellent prognosis with appropriate treatment. However, the same does not hold true for other subtypes of TGDC. In a series of nine patients with TGDC squamous cell carcinoma, three patients were dead of disease at 15 months after diagnosis, indicating a much worse prognosis in this more aggressive tumor (49).

Ectopic Intratracheal Thyroid Cancer (EITC)

Epidemiology and clinical presentation

Intratracheal ectopic thyroid tissue is a rare developmental abnormality accounting for a minority of cases of ectopic thyroid tissue and from 1–7% of all primary endotracheal tumors (50–52). The incidence of malignancy in intratracheal ectopic thyroid tissue varies from 1.6% (53) to 14% (50). Both ectopic thyroid tissue and cancer arising from this tissue can cause symptomatic, even life-

threatening upper airway obstruction (55–58) or asthma-like symptoms (59).

Treatment

Treatment options for EITC include surgical excision and thyroid hormone suppression. The treatment of choice is surgical excision, predominantly using an endoscopic approach (60). Thyroid suppression is given postoperatively to prevent hypertrophy of residual tissue. Treatment with radioiodine remains very controversial and might even be contraindicated due to the critical location of intratracheal ectopic thyroid tissue. Radioiodine ablation would carry a risk of radiation-induced tracheitis, potentially contributing to worsening of the airway obstruction. On the other hand, intratracheal ectopic thyroid tissue may not take up iodine as effectively as the normally located thyroid gland (52). It should be emphasized that ectopic intratracheal thyroid is usually accompanied by an orthotopic thyroid gland that would also be destroyed or damaged by radioactive iodine treatment (52). There are no data in the literature regarding the risk of malignancy and the proper management of the orthotopic thyroid gland in patients treated for EITC.

Other Rare Locations of Midline Ectopic Thyroid Cancer

Epidemiology and clinical presentation

Ectopic thyroid tissue may be located anywhere from the base of the tongue down to the diaphragm. There are several case reports describing midline neck ectopic thyroid tissue harboring malignancy (61–63). For example, there are single case reports describing PTC (64) and insular variant thyroid cancer (65) arising from mediastinal ectopic thyroid tissue.

Treatment

The most appropriate management is the surgical excision of the cancer arising from the ectopic thyroid tissue, although there are very scant data regarding treatment efficacy and follow-up strategy. Yoshino *et al.* (64) documented successful excision of ectopic mediastinal PTC using a lateral incision for a thoracotomy and a modified transmanubrial approach, resulting in a lack of recurrence during the follow-up period of 14 months. There are no data regarding the risk of metastatic spread of these tumors and potential application of I-131 in the course of the treatment. There is an ongoing discussion regarding whether or not to proceed with the resection of the orthotopic thyroid gland. In our view, the approach should be individualized and based on the evaluation of the thyroid

gland, including palpation and a thyroid sonogram with appropriate management of nodules if identified (45).

Lateral Neck Ectopic Thyroid Cancer

Epidemiology and clinical presentation

Precise epidemiological data regarding the incidence and prevalence of lateral neck ectopic thyroid cancer are lacking because it is often extremely difficult to distinguish primary neoplastic involvement of ectopic thyroid cancer from laterocervical lymph node metastasis. Perhaps the best confirmation that the tumor reflects ectopic thyroid cancer in the lateral neck rather than metastatic disease from the thyroid gland rests on the failure to detect primary tumor within the thyroid despite careful pathological examination of finely sectioned slices of the entire thyroid gland. Indeed, the entity of “metastases of clinically undetected thyroid carcinoma” is likely to be overdiagnosed and often represents ectopic PTC (66). Choi and Kim (67) described such a case of an ectopic thyroid gland at the lateral neck masquerading as metastatic PTC.

Cabibi *et al.* (68) proposed the utilization of immunohistochemical techniques as a useful tool in differential diagnosis. They examined the expression of galectin-3, cytokeratin 19, and mesothelioma antibody HBME-1 in six cases of laterocervical masses harboring PTC but without a thyroid tumor, and in eight cases showing PTC both in the thyroid and in the laterocervical masses. They found that the normal follicles of the six patients with ectopic thyroid cancer were negative for galectin-3, cytokeratin 19, and HBME-1, whereas the markers were all positive in the patients with metastatic orthotopic thyroid cancer. Ectopic lateral neck thyroid cancer has been documented to occur either unilaterally (69) or bilaterally (70). The next case illustrates the difficulty of the differential diagnosis of the pathological process involving the lateral neck ectopic thyroid tissue.

Case 4

A 31-yr-old woman presented from another facility for a second opinion regarding the need for total thyroidectomy. She had undergone biopsy of a 1.5-cm mass in the lateral neck that was said to contain thyroid carcinoma in a lymph node. Physical examination and ultrasonography of the neck were unremarkable, including the thyroid gland. The slides were obtained and reviewed by Dr. James Oertel of the Armed Forces Institute of Pathology, and the diagnosis of Hashimoto thyroiditis in lateral neck aberrant thyroid tissue was made instead. TSH and free T₄ were normal, both antithyroperoxidase and antithyroglobulin antibodies were positive, and the patient was ad-

vised not to undergo thyroidectomy. The patient was lost to follow-up until she returned 10 yr later having had a total thyroidectomy at another distant institution. She reported that physicians there had again biopsied a “lymph node” in the neck and were certain that she had thyroid cancer and had strongly advised surgery. The pathology report indicated a normal thyroid gland with no nodules and no cancer.

Treatment

Due to the extreme rarity of such cases, there are no standard evidence-based recommendations regarding the optimal treatment of ectopic lateral neck thyroid cancer. Total thyroidectomy with excision of the ectopic thyroid tissue and bilateral neck dissection was proposed by Wang *et al.* (70) for a patient with submental ectopic PTC presenting as bilateral progressively growing neck masses. In this case, no primary lesions were found in the thyroid gland. We believe the most reasonable approach to be individualized risk stratification based on magnetic resonance imaging and/or ultrasonographic imaging studies of the orthotopic thyroid gland and cervical lymph nodes that would guide the extent of the surgery. There are no data regarding the efficacy of treatment with ¹³¹I in such cases.

Branchial Cleft Cyst Ectopic Thyroid Cancer

Epidemiology and clinical presentation

Branchial cleft cysts have been considered as one of the most common congenital anomalies among neck masses and are believed to result from incomplete involution of the branchial cleft structures during embryonic development. This theory is supported by the suggestion that the fourth branchial pouch follicular cells contribute to the development of the lateral thyroid lobes. Conversely, a recent theory proposed that these lesions are associated with epithelial cell penetration of lymph nodes in the branchial cleft (71). Thyroid carcinoma arising in ectopic thyroid tissue within a branchial cyst is extremely rare, with approximately eight cases documented in the literature (71–76).

Treatment

As is the case with lateral neck ectopic thyroid tissue, it is often difficult to determine whether a cancer in a branchial cleft cyst represents metastatic thyroid carcinoma with an undetected primary tumor or ectopic thyroid carcinoma arising in a branchial cleft cyst. Both clinical situations have been described in the literature. There are two reported cases of ectopic PTC in a branchial cleft cyst

without any evidence of occult thyroid cancer in the orthotopic thyroid or cervical lymph nodes, suggesting a *de novo* process (71). On the other hand, there are well-documented cases of branchial cleft cyst cancer with concurrent lymph node metastasis and PTC present in the orthotopic thyroid (77). When a branchial cleft cyst is diagnosed by clinical or histopathological examination, a metastatic PTC should be considered as part of the differential diagnosis (77). Consequently, Hofman *et al.* (72) advocate that complete thyroidectomy may be necessary to rule out the possibility of an occult thyroid carcinoma. A parallel controversy exists in regard to the necessity of performing neck dissection. There are case reports describing thyroid carcinoma arising in ectopic thyroid tissue that had metastasized to the cervical lymph nodes (54). Again, the extent of the surgery to be performed should be based on individualized clinical judgment.

Summary and Conclusions

Thyroid cancer arising from ectopic thyroid tissue in the neck occurs rarely and may represent either a *de novo* or metastatic process. The possibility of an ectopic thyroid cancer in the setting of a normal thyroid gland should be considered in the differential diagnosis of a pathological mass in the neck. Treatment of ectopic cervical thyroid cancer is based predominantly on the surgical excision of the malignant lesion. Management strategies, including performance of total thyroidectomy, neck dissection, and treatment with radioiodine, should be based on individualized risk stratification.

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