AJNR

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AJNR Am J Neuroradiol 1990, 11 (2) 361-367
http://www.ajnr.org/content/11/2/361

CT Evaluation of Anaplastic Thyroid Carcinoma

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CT findings in 19 patients with anaplastic thyroid carcinoma were compared retrospectively with pathologic findings and the results of palpation. The carcinoma appeared as a large mass of low attenuation accompanied by dense calcification in 58% of the patients; there was necrosis in 74%. Often, adjacent structures were infiltrated. CT correctly showed tumor invasion of the carotid artery (7/7), internal jugular vein (9/10), larynx (5/6), trachea (8/10), esophagus (4/5), mediastinum (5/5), and regional lymph nodes (14/16). Seven patients (50%) had necrotic nodes. CT was superior to palpation in the detection of a primary tumor in one patient and of metastatic nodes in seven patients. It suggested a suitable place for biopsy in two patients, leading to a correct diagnosis. CT altered surgical planning in five patients with intrathoracic extension of the thyroid tumor, and in three patients with laryngeal or esophageal invasion of the tumor.

CT can increase diagnostic accuracy in patients with anaplastic thyroid carcinoma by suggesting a likely diagnosis and by indicating an appropriate site for biopsy. It is indispensable in the planning of surgery for patients with this disorder.

***AJNR* 11:361–367, March/April 1990; *AJR* 154: May 1990**

Anaplastic carcinoma of the thyroid gland accounts for 4–15% of all thyroid malignancies; it affects women slightly more often than men [1–5]. The peak occurrence of this disorder is during the seventh decade of life. Most patients with the disease have a rapidly enlarging thyroid mass and symptoms of obstruction such as dyspnea and dysphagia. Hoarseness due to recurrent laryngeal nerve palsy is often seen. Such clinical features are very similar to those of primary thyroid lymphoma [6–8]. Primary thyroid lymphoma accounts for 4% of all thyroid malignancies [6], and secondary thyroid gland involvement is found incidentally in 15% of patients with systemic malignant lymphoma at autopsy [9]. Thyroid lymphoma in the early stages has a relatively good prognosis [6, 8]. Burke et al. [10] mentioned that the 5-year survival rate for patients with stage IE lymphoma is as high as 89%, and that the 5-year survival rate for those with stage IIE disease is 27%. Patients in whom thyroid lymphoma is confined to the neck are treated with radiation therapy, with or without chemotherapy; surgery is not the treatment of choice [6, 10].

In early reports, the outcome of patients with anaplastic thyroid carcinoma was almost invariably fatal within a year from diagnosis; the median survival from the time of diagnosis was 3–6 months [1–5]. The survival period in recent reports, however, has been improved as a result of a combination of surgery, hyperfractionated radiotherapy, and chemotherapy [11–13]. Werner et al. [13] reported that patients with distant metastases and/or vocal cord paralysis had a median survival time from diagnosis of 7 months, and that patients with less advanced disease survived on average 12 months with the use of such multimodal therapy. Many authorities think that tumor resection can extend the survival time and that, when possible, radical removal of the tumor should be performed [2–4, 13–15]. Therefore,

Received May 11, 1989; revision requested August 2, 1989; revision received September 12, 1989; accepted September 21, 1989.

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0195-6108/90/1102-0361

it is important to establish a final diagnosis promptly, to define the tumor extent, and to identify the site and extent of metastatic lymph nodes preoperatively. We studied whether there are any features of anaplastic thyroid carcinoma seen on CT that distinguish it from primary thyroid lymphoma. The CT findings were compared with those of surgery, pathology, and palpation, and the role of CT in the management of the patients with the disease was studied.

Materials and Methods

We retrospectively analyzed the clinical data and CT findings in 19 patients with anaplastic thyroid carcinoma who underwent CT for diagnosis or staging of the cancer between June 1983 and November 1988. Histologic diagnosis was by surgical specimens in 17 patients and by autopsy in two. The 11 women and eight men were 35–87 years old (mean, 65 years). CT was performed with an 8800 CT/T or 9800 CT scanner (General Electric, Milwaukee) or a CT 8600 scanner (Yokogawa, Tokyo). Scans were obtained through the neck and thyroid masses principally with contiguous 5-mm-thick sections. Nine patients were studied with both plain and contrast-enhanced scanning. The other 10 patients were studied with contrast-enhanced scanning only. Contrast enhancement was always required to distinguish enlarged lymph nodes from vascular structures; it also provided important information about the presence or absence of necrosis in the masses and their relationship to surrounding structures. Contrast enhancement was attained with a rapid drip infusion of 100 ml of 65% iodinated contrast material administered IV. Special attention was paid to the tumor extent in the thyroid gland, tumor invasion of surrounding structures, site and extent of metastatic lymph nodes, and presence of calcification or necrosis in the tumor.

The CT findings were compared with pathologic or surgical findings, and also with those of palpation, which was performed by a surgeon specializing in the head and neck to detect primary tumors and metastatic lymph nodes. On CT images, lymph nodes in the submandibular and jugulodigastric regions of the internal jugular chain that were larger than 1.5 cm in their greatest diameter were considered to have a metastasis [16]. For the other nodes in the neck and those in the mediastinum, a diameter of more than 1 cm was considered to show metastasis. Any nodes with central necrosis, regardless of size, were also considered to be metastatic. Picus et al. [17] found that if the esophageal carcinoma was in contact with 90° or more of the aortic circumference on CT, aortic invasion by the tumor was very likely. Mancuso [18] used the same criteria to predict the carotid invasion by the cervical nodal metastases. We modified the same rule to define tumor invasion of adjacent structures. Tumor invasion of surrounding structures such as the common carotid artery, internal jugular vein, larynx, trachea, and esophagus was diagnosed if the tumor was in contact with one-half or more of the circumference of such organs, and if the plane between them was lost. When ossified cartilage invasion of the larynx was present, tumor invasion was diagnosed also.

Results

Goiter had been present in nine patients (47%) for 3 months to 30 years before the diagnosis of anaplastic carcinoma. Five patients had had surgery for thyroid tumors before the diagnosis of anaplastic carcinoma was established: three for papillary carcinoma and two for thyroid adenoma. Fourteen patients (74%) had had a rapidly enlarging neck mass. Symptoms of obstruction were reported by 17 patients (89%),

TABLE 1: CT Findings in Anaplastic Thyroid Carcinoma

Case No.	Age	Sex	Primary Site			Metastatic Lymph Nodes				Intrathoracic Extension/ Location
			Extent	Necrosis	Calcification	Palpation	CT	Pathology	Necrosis	
1	80	F	Both lobes, isthmus	Yes	Yes	No	No	Yes	–	No
2	63	F	Both lobes, isthmus	Yes	Yes	No	Yes	Yes	Yes	No
3	71	M	One lobe, isthmus	No	Yes	Yes[a]	Yes	Yes	No	No
4	60	M	One lobe, isthmus	Yes	Yes	Yes[a]	Yes	Yes	No	No
5	70	M	Both lobes, isthmus	Yes	Yes	Yes[a]	Yes	Yes	Yes	Yes/middle mediastinum
6[b]	64	F	–	–	–	Yes	Yes	Yes	Yes	No
7	80	F	One lobe, isthmus	Yes	Yes	No	No	Yes	–	No
8	57	F	Both lobes, isthmus	No	No	No	No	No	–	No
9	61	M	One lobe	No	No	No	No	No	–	Yes/middle mediastinum
10	72	F	One lobe, isthmus	Yes	No	Yes[a]	Yes	Yes	No	No
11	35	M	One lobe[c]	No	No	No	Yes	Yes	No	No
12	59	F	Both lobes[c]	Yes	No	Yes	Yes	Yes	Yes	No
13	57	M	One lobe	Yes	No	Yes	Yes	Yes	Yes	No
14	85	F	One lobe, isthmus	Yes	Yes	No	No	No	–	No
15	65	F	One lobe, isthmus	Yes	Yes	No	Yes	Yes	No	Yes, middle mediastinum
16	87	F	One lobe, isthmus	Yes	Yes	Yes	Yes	Yes	Yes	No
17	57	F	Both lobes, isthmus	Yes	Yes	No	Yes	Yes	No	Yes/anterior mediastinum
18	48	M	One lobe	Yes	No	Yes[a]	Yes	Yes	Yes	No
19	65	M	One lobe	Yes	Yes	Yes[a]	Yes	Yes	No	Yes/posterior mediastinum

[a] More metastatic nodes were detected by CT than by palpation.
[b] This patient had had a total thyroidectomy.
[c] Multiple lesions were found on pathologic studies.

recurrent nerve palsy by seven (37%), and neck pain by nine (47%). Fifteen patients had normal serum thyroid hormone levels; the other four were taking thyroid hormone after thyroidectomies. Antithyroid autoantibodies were positive at low titers in four of the 11 patients tested.

Fifteen patients underwent needle aspiration cytology preoperatively. Ten patients (67%) were diagnosed as having or as suspected of having anaplastic carcinoma. In two of these 10 patients, the correct diagnosis was made by repeated aspiration biopsies after CT examinations that indicated appropriate sites for sampling. One patient was falsely diagnosed as having squamous cell carcinoma, one as having adenocarcinoma, and one as having an unspecified malignancy; two had negative results. Later, two of these patients underwent needle biopsy; one had open biopsy. The correct diagnosis was then obtained in all three. Histologic study showed seven cases of spindle cell tumor, five of giant cell tumor, and three of pleomorphic cell tumor. For the remaining four tumors, the type of anaplastic carcinoma was not identified. Eleven patients (58%) had other thyroid cancers, either in the thyroid gland or in the metastatic lymph nodes: papillary carcinoma (10 patients), follicular carcinoma (three patients), and squamous cell carcinoma (one patient).

Table 1 summarizes the CT findings of anaplastic carcinoma in comparison with those of pathology and palpation. Eighteen patients had a solitary mass on CT that was palpated as a hard mass; in one of these patients, another small nodule of anaplastic carcinoma measuring 4 mm in diameter was found in the thyroid on pathologic examination but not on palpation. In the remaining patient, multiple small nodules that were not palpable were depicted on CT. Tumors were generally identified as inhomogeneous isodense or slightly hyperdense areas relative to skeletal muscle on CT; contrast enhancement was not necessary to depict the site of the primary tumor. Tumor necrosis was identified as areas of lower attenuation than that of the skeletal muscle; areas of necrosis did not enhance with contrast material (Figs. 1, 2, 3B, 3C, 4B, and 4C). Calcification (Figs. 1A and 4C) and necrosis (Figs. 1B, 2A, and 3B) in the primary tumors were detected in 10 (58%) and 14 (74%) patients, respectively. All calcification was of the dense, amorphous type. Necrosis of the tumor was extensive in four cases (21%) (Fig. 2A).

Regional lymphadenopathy was found on CT in 14 patients (74%). Of these 14 patients, seven had central necrosis in the involved nodes; the remaining seven had nonnecrotic nodes (Figs. 2 and 3A). CT detection of metastatic nodes in each anatomic region was compared with that by palpation and pathology (Table 2). In four patients, histologically proved metastatic nodes were detected by neither palpation nor CT: two patients (cases 1 and 7) had normal-sized lymph nodes with microscopic tumor deposits; the other two had enlarged nodes containing tumor deposits in the middle or inferior internal jugular chains or both. Metastasis was not found by palpation but was found by CT in 10 cases: eight nodes in the tracheoesophageal groove or in the superior mediastinum, three in the inferior internal jugular chain, two in the middle internal jugular chain, and two in the spinal accessory chain. One node with metastasis on CT and without metastasis by palpation was found to be reactive.

Table 3 summarizes the CT detection of tumor infiltration into adjacent structures. Tumor invasion of the common carotid artery was predicted by CT in eight patients (Fig. 2). Of these, one patient (case 2) had a false-positive result. Tumor invasion of the internal jugular vein was predicted in nine cases (Figs. 3A and 3B); one result (in case 15) was false negative (Fig. 3C). Laryngeal invasion was seen on CT in five patients (Figs. 3B and 4A). Of these, four patients had tumor invasion of ossified cartilage of the larynx. The result was a false negative in one patient. Laryngectomy was performed in one of the patients with laryngeal invasion of the tumor. Tracheal invasion was detected by CT in 10 patients (Fig. 1); false-positive (Fig. 4B) and false-negative (Fig. 2B) results were obtained in two cases each. Invasion of the esophagus was seen on CT in five patients (Figs. 1 and 4A); the results were false negative and false positive in one patient each. Partial esophagectomy was done in two of the patients with esophageal invasion of the tumor. Intrathoracic extension of the thyroid tumor was detected in five patients (Fig. 4C).

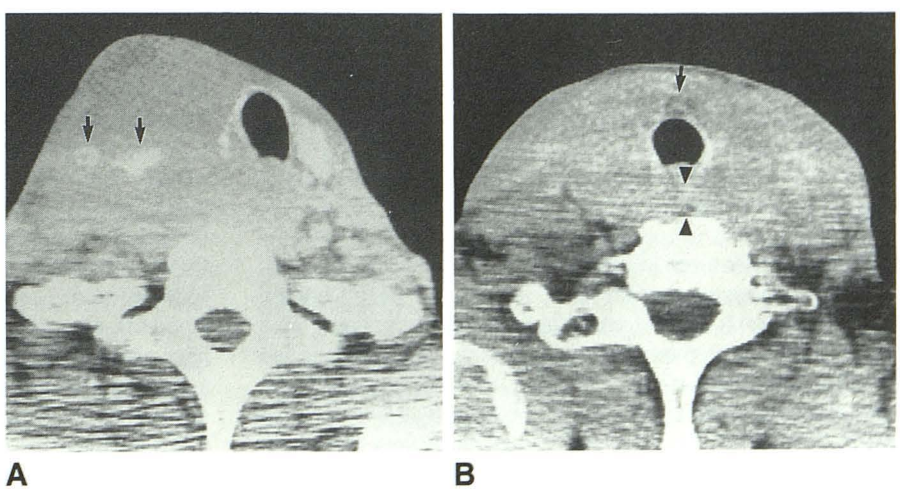


Fig. 1.—Anaplastic thyroid carcinoma with and without necrosis.

***A*, Primary site without necrosis in Case 3. Contrast-enhanced CT scan shows large mass of low attenuation with amorphous calcifications (*arrows*); mass replaces entire right lobe of thyroid gland. Necrosis cannot be seen. Trachea is displaced to the left, and tumor is in contact with more than half of circumference of trachea, with loss of tissue plane between them. Discrimination between tumor and esophagus is difficult, because tumor encroaches on it. Tumor infiltration of trachea and esophagus predicted by CT was found during surgery.**

***B*, Primary site with small area of necrosis in case 5. Contrast-enhanced CT scan shows low-attenuation mass replacing entire thyroid gland. Small necrotic portion (*arrow*) is seen in thyroid isthmus. Trachea and esophagus (*arrowheads*), surrounded by tumor on more than three sides, were found to be infiltrated by tumor during surgery.**

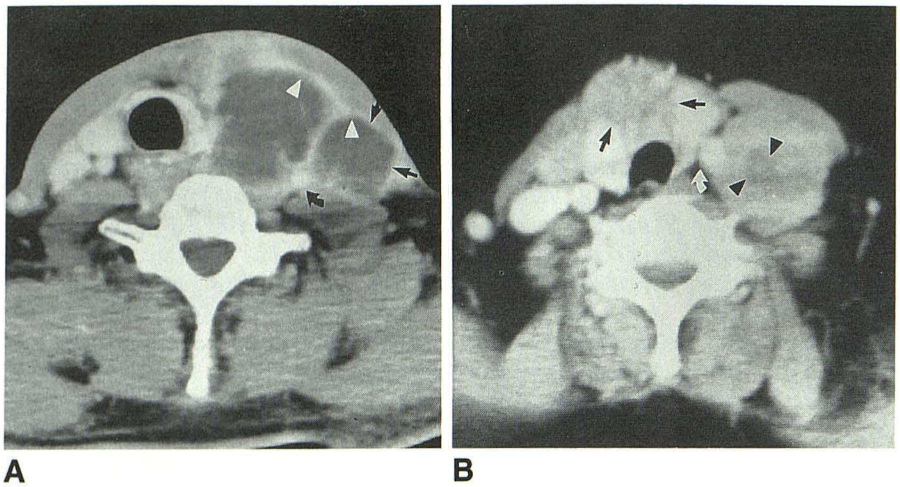


Fig. 2.—Tumor invasion of common carotid artery.

A, True-positive diagnosis in case 18. Contrast-enhanced CT scan shows rim-enhancing mass with extensive necrosis in left lobe of thyroid gland and necrotic nodal mass (*straight arrows*) in inferior internal jugular chain. Interface between tumor and sternocleidomastoid muscle (*arrowheads*) is irregular. Tumor encircles left common carotid artery (*curved arrow*) on more than half of its circumference with loss of plane between them. Left internal jugular vein has been obliterated. Tumor invasion of these structures predicted by CT was confirmed by pathologic or surgical studies.

B, False-positive diagnosis in case 2. Low-attenuation mass (*straight arrows*) and nodal mass with small area of necrosis (*arrowheads*) in inferior internal jugular chain are seen on contrast-enhanced CT. CT suggested that tumor had invaded left common carotid artery (*curved arrow*) but not trachea. However, surgical findings showed that tumor had infiltrated trachea but not carotid artery.

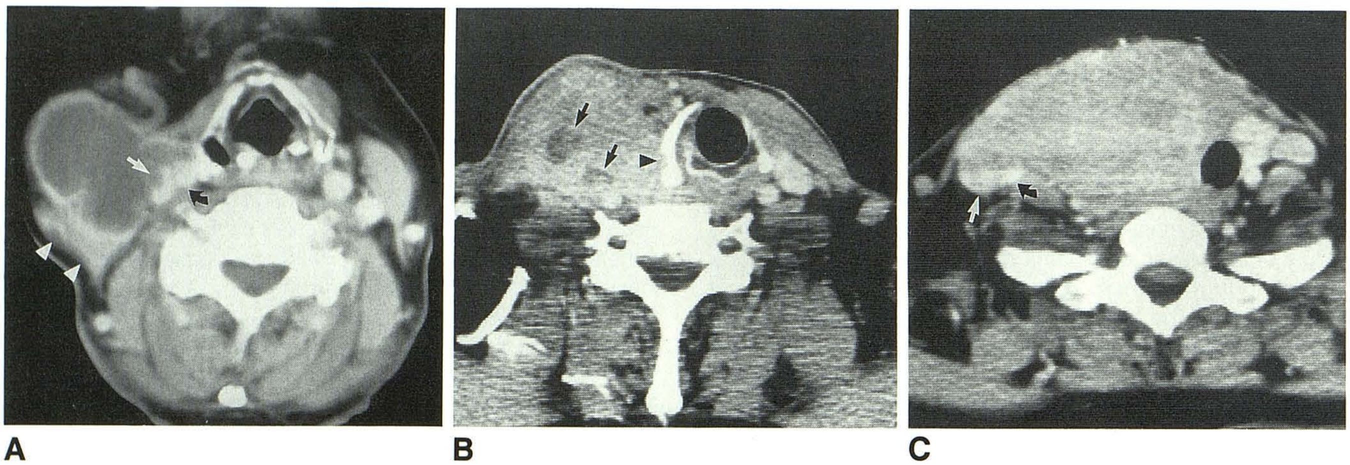


Fig. 3.—Tumor invasion of internal jugular vein.

A, True-positive diagnosis in case 16. Contrast-enhanced CT scan shows large necrotic node in middle internal jugular chain on right. Border between tumor and internal jugular vein (*straight arrow*) is irregular. Ipsilateral sternocleidomastoid muscle (*arrowheads*) is posteriorly displaced and deformed. Pathologic studies confirmed tumor invasion of internal jugular vein and muscle; common carotid artery (*curved arrow*) was dissected free during surgery.

B, True-positive diagnosis in case 4. Large, low-attenuation mass with few foci of necrosis (*arrows*) is seen in right lobe of thyroid gland on contrast-enhanced CT. Ipsilateral internal jugular vein has been obliterated, and tumor invasion of ossified thyroid cartilage (*arrowhead*) is seen. Tumor infiltration of internal jugular vein and thyroid cartilage was confirmed by pathologic or surgical studies, findings compatible with those on CT.

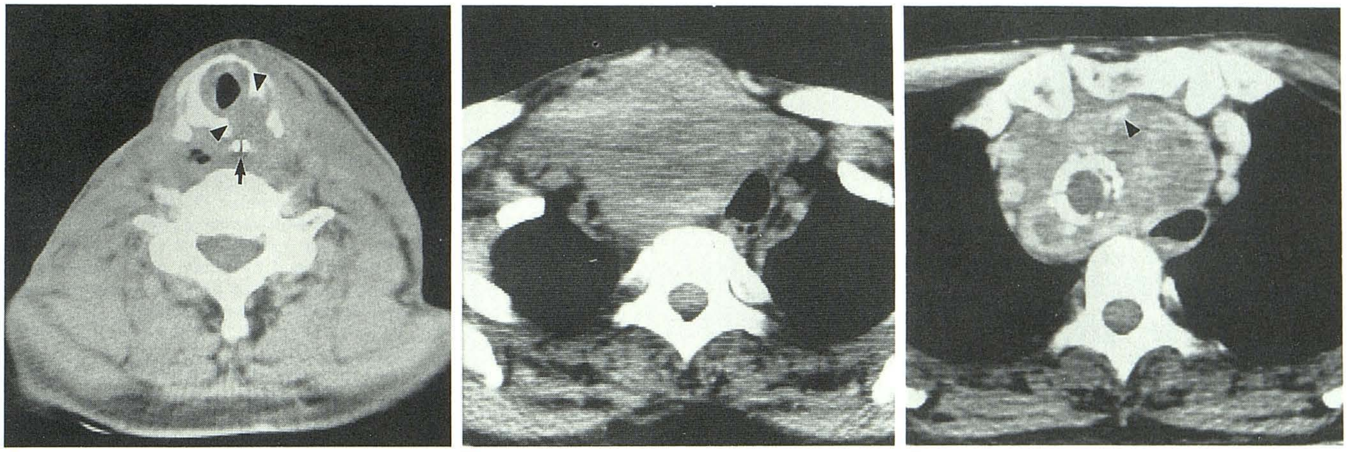
C, False-negative diagnosis in case 15. Contrast-enhanced CT scan shows low-attenuation mass in right lobe and isthmus of thyroid gland. Tumor invasion of adjacent vessels was not predicted by CT. However, pathologic specimens from surgery showed tumor infiltration of internal jugular vein (*straight arrow*); common carotid artery (*curved arrow*) was easily separated from tumor during surgery.

Thoracotomy was performed in these five patients; contiguous spreading of the thyroid tumor was found in all.

Discussion

The clinical features in our patients are similar to those of patients previously reported [1–5, 11, 14, 15]. In this series, thyroid function tests were normal in all but the patients who had had thyroidectomies. Antithyroid antibodies were positive in four patients, but at low titers. Such results were different from those reported previously for primary thyroid lymphoma [7]. Patients with thyroid lymphoma usually have antimicrosomal antibodies at high titers because superimposed Hashimoto thyroiditis is always present; these patients often have hypothyroidism.

Many researchers think that anaplastic thyroid carcinoma results from the transformation of preexisting well-differentiated thyroid carcinoma, and that, in most cases, the areas of well-differentiated carcinoma can be identified if sufficient tissue is available for pathologic examination [2–5, 14, 19]. Aldinger et al. [5] reported that 89% of their cases showed elements of well-differentiated carcinoma. The relatively low frequency of coexisting well-differentiated carcinoma in our series may have resulted from the fact that only small portions of the resected specimen were used for pathologic examination. However, the presence or absence of well-differentiated carcinoma will not affect surgical planning.



A B C

Fig. 4.—*A*, Laryngeal invasion in case 13. Laryngeal invasion by tumor was diagnosed by CT, because ossified cricoid cartilage (*arrowheads*) had been partly destroyed by tumor. Nasogastric tube (*arrow*) is seen in esophagus, which has been encroached on by tumor. Pathologic studies showed tumor invasion of larynx and esophagus.

B, False-positive diagnosis of tracheal invasion in case 15. Trachea has been displaced to the left and is compressed by large mass. Tumor surrounds trachea on more than half of its circumference. Tumor invasion of trachea was predicted by CT, but trachea was dissected free from tumor during surgery.

C, Intrathoracic extension of thyroid tumor in case 15. Tumor extension into mediastinum is seen. Dense amorphous calcifications (*arrowhead*) are present in mass. Thoracotomy was performed in this patient for total removal of tumor.

TABLE 2: Detection of Metastatic Nodes by CT and Palpation Compared with Pathology

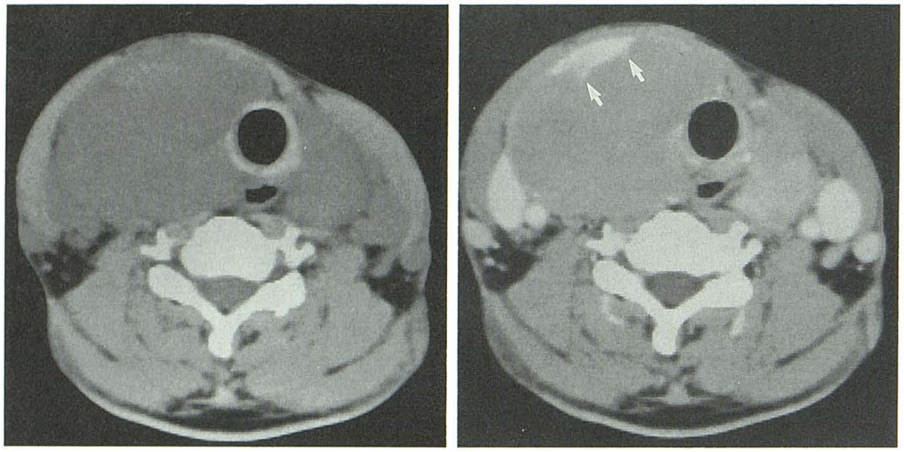
Palpation/CT	Pathology: Positive	Pathology: Negative
Palpation negative		
CT negative	4	3
CT positive	10	1
Palpation positive		
CT positive	10	0
CT negative	0	0

TABLE 3: CT Detection of Tumor Invasion of Adjacent Structures vs Surgical or Pathologic Findings

Structure	CT Finding			
	True Positive	True Negative	False Positive	False Negative
Common carotid artery	7	11	1	0
Internal jugular vein	9	9	0	1
Larynx	5	13	0	1
Trachea	8	7	2	2
Esophagus	4	13	1	1
Mediastinum	5	14	0	0

In our series, anaplastic carcinoma of the thyroid was manifested by relatively large masses that were isodense or slightly hyperdense relative to skeletal muscle; calcification (53%) and necrosis (74%) usually were present, and often were extensive. One-half of the patients had necrotic nodes. Calcification of the tumors was invariably dense. Such calcification is seen in both benign and malignant tumors, but is more common in benign masses [20]. Precise correlation of CT findings with pathology in four patients in our study revealed that well-differentiated carcinoma surrounded the calcification in the masses, while anaplastic carcinoma was relatively remote from the calcification; however, CT could not discriminate between these tumors. Because 47% of our patients had had goiters for a long time, this condition may have caused the calcification. Meanwhile, primary thyroid lymphoma appeared as large, homogeneous masses that were isodense or hyperdense relative to skeletal muscle on CT; contrast enhancement was usually required to better detect the primary tumor site because Hashimoto thyroiditis was always present (Fig. 5) [7, 8]. Moreover, thyroid lymphoma is rarely calcified (7%) or necrotic (7%), and lymphomatous nodes are rarely necrotic [7, 8]. Even if the primary tumor develops an area of necrosis, its proportion to the total tumor size is small.

As already reported [1, 3, 15], anaplastic thyroid carcinoma in our study often invaded neighboring structures such as the carotid artery (37%), internal jugular vein (53%), larynx (32%), trachea (53%), esophagus (26%), and regional lymph nodes (84%), as judged by pathologic or surgical findings. CT accurately showed tumor spread to the vascular structures and regional lymph nodes, but prediction of tumor invasion of the trachea or esophagus by CT was not reliable. Primary thyroid lymphoma also invades adjacent vascular and visceral structures [7, 8, 10]. Burke et al. [10] reported that 18 (51%) of 35 cases showed invasion into the surrounding tissues and that five (14%) involved the regional lymph nodes. In our previous study of 16 patients with primary thyroid lymphoma [8], surgically proved carotid invasion was present in three patients (19%), laryngeal invasion in one (6%), regional lymph-node involvement in seven (44%), and intrathoracic extension of the thyroid tumor in two (13%). Thus, we suggest that



A B

Fig. 5.—Primary thyroid lymphoma.

A, Plain CT scan shows enlarged thyroid gland with generally reduced attenuation and displacement of larynx and esophagus to left. Discrimination between unaffected areas and lymphoma is impossible.

B, Contrast-enhanced CT scan shows homogeneous masses to be isodense relative to skeletal muscle in both lobes and isthmus of thyroid gland. Small unaffected thyroid tissue is seen (*arrows*) in anterior portion of right lobe of thyroid gland. Anterior portion of left lobe of thyroid gland is replaced by tumor, but interface between posterior portion of tumor in left lobe and residual thyroid tissue is indistinct.

anaplastic thyroid carcinoma more frequently invades the surrounding structures and more often involves the regional lymph nodes than primary thyroid lymphoma does.

Benign and malignant conditions overlap on CT images [21–23]. Multinodular goiter appears on CT as multiple regions of decreased density often accompanied by dense calcifications randomly scattered throughout the thyroid gland [21]. The multiplicity of this nodule should be useful in differentiating it from anaplastic thyroid carcinoma. In their report of CT findings in 67 patients with various thyroid tumors, Shibakiri et al. [23] mentioned that an inhomogeneous solid pattern, one of their seven CT patterns, was found in 11 of 23 follicular carcinomas, nine of 19 papillary carcinomas, two of two medullary carcinomas, and two of two anaplastic carcinomas. We believe that primary thyroid lymphoma can be reliably discriminated from other conditions if the clinical and CT criteria described in our previous report [7] are followed. Seven recent patients with thyroid lymphoma were strongly suspected of having the disorder on the basis of CT and clinical data, and, after histologic diagnosis made with biopsy procedures, unnecessary surgery was avoided. We also suggest that, with our criteria, a probable diagnosis of anaplastic thyroid carcinoma can be ventured. If CT scans show invasive isodence or hyperdense masses in the thyroid of patients who have either symptoms of obstruction or a rapidly enlarging neck mass, if there is no evidence of Hashimoto thyroiditis, and if additional features such as calcification or necrosis are present, then the most likely diagnosis is anaplastic carcinoma. The final diagnosis, however, must depend on the results of a biopsy. Nonetheless, the tentative CT diagnosis will contribute to an early final diagnosis.

Several authors have reported that the diagnosis of anaplastic thyroid carcinoma can be made by needle aspiration cytology [13, 24, 25]. Ten (67%) of 15 cases in our series were correctly diagnosed with this procedure. In two of these patients, CT information was useful in establishing the definite diagnosis. Three patients were diagnosed as having well-differentiated carcinoma or a malignancy, and two patients in whom the diagnosis was negative on the basis of needle aspiration cytology were found by CT to have extensive necrosis in the tumor. Thus, we believe that when anaplastic thyroid carcinoma is suspected, multiple aspirates should be sampled from different parts of the remaining solid portion of the tumor that is remote from the calcification; this tumor often is necrotic and frequently there is coexisting well-differentiated carcinoma. Radiologic information on the extent and location of tumor necrosis and site of calcification in the tumor will lower the prevalence of false-negative diagnoses. No patient in our study was studied by this technique, but image-guided biopsy should increase the accuracy of the diagnosis in the head and neck region [26, 27].

CT and palpation were nearly comparable in the detection of primary tumors; however, CT was superior to physical examination in one patient in whom small nodules in the thyroid gland were identified by CT but not by palpation. Moreover, CT defined the extent of the masses in the thyroid gland more exactly than physical examination did, and CT discriminated between primary tumors and adjacent enlarged nodes; this could not be done by palpation. In eight patients (42%), surgical planning was modified in light of CT findings: in five, the mediastinal approach was chosen because of intrathoracic extension of the thyroid tumor; in three, partial esophagectomy or laryngectomy was added.

Mancuso et al. [28] reported that 5% of metastatic nodes from head and neck cancer will not be palpable but will be detected by CT because these nodes lie deep under the sternocleidomastoid muscle or in areas that are not accessible on physical examination, such as in the regions of the retropharyngeal or tracheoesophageal grooves. In 53% of our cases (10 patients), more information about the metastatic nodes was obtained by CT than by palpation. Our detection rate of such nodes by palpation was lower than generally reported in the literature [28, 29], possibly because the nodes frequently were in areas beyond the limits of palpation or because the nodes in the middle, inferior internal jugular chain or in the spinal accessory chain were behind the large primary tumors. Information about the presence of metastatic nodes alone did not considerably alter the surgical plan, but the detection of involved nodes, especially those in the superior mediastinum, and the discovery of their extent were useful in planning.

Thus, our study has shown that a likely diagnosis of anaplastic thyroid carcinoma can be obtained by the combination of CT and clinical findings. CT can improve diagnostic accuracy in the disease by suggesting an appropriate site for biopsy; it is indispensable in the planning of surgery.

ACKNOWLEDGMENTS

We thank Fumio Matsuzuka, Kuma Hospital, for clinical data; Hitoshi Yamamoto for advice; Chieko Watanabe for secretarial assistance; and Miwako Takashima for help in manuscript preparation.

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