CT of Adenoid Cystic Carcinoma of the Trachea

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The CT features of six cases of adenoid cystic carcinoma of the trachea are presented and compared to the bronchoscopic, surgical, and pathologic findings. CT accurately demonstrated extratracheal extension of tumor, which occurred in all six cases and which was not visible on standard chest radiographs. This information was helpful in planning the surgical approach. However, CT consistently underestimated the longitudinal extension of the lesion because of partial volume averaging and the tendency of adenoid cystic carcinoma to grow submucosally. CT was also a poor predictor of mediastinal organ invasion. Because recent advances in tracheal resection and carinal reconstruction have made many of these lesions resectable, CT is frequently used in the evaluation of the operability of patients with adenoid cystic carcinoma. However, its usefulness in this regard is limited, and conventional techniques such as standard tomography continue to play a role in preoperative assessment.

Adenoid cystic carcinoma is the second most common primary tumor of the trachea [1]. Although originally classified as a bronchial adenoma, adenoid cystic carcinoma is actually a malignant tumor that may metastasize to the lungs, liver, abdominal lymph nodes, or bone [2]. Recent advances in tracheal resection and reconstruction have made surgical removal and cure of these lesions possible even when they are extensive and involve the carina and mainstem bronchi [3, 4]. Accurate preoperative mapping and staging are therefore essential.

The standard radiographic and tomographic features of this tumor have been reported previously [4]. We undertook this study to determine the CT features of six cases of adenoid cystic tumor with particular reference to the role of CT in the preoperative imaging of these lesions.

Materials and Methods

The CT scans of six patients with pathologically proven adenoid cystic carcinoma were retrospectively reviewed by three radiologists with experience in thoracic imaging, and the results were compared to the bronchoscopic, surgical, and pathologic findings. All scans were performed on third- or fourth-generation scanners; two scans on EMI 7070 (Hayes, Middlesex, England), two on GE 8800 (Milwaukee, WI), one on Seimens Somaton DR2 (Iselin, NJ), and one on Pfizer 450. In five instances contiguous 10-mm sections were obtained. A single case was imaged with 8-mm sections. IV contrast material was used in those cases in which the tumor abutted vascular structures, that is, the arota or pulmonary artery. The CT scans were examined for the following features: (1) location of the tumor; (2) extent of tracheal involvement; (3) the presence of carinal, right or left main, and distal bronchial extension; (4) mediastinal invasion; and (5) the presence of lung, pleural, and mediastinal lymph node metastases. Mediastinal lymph nodes were considered positive if they were larger than 1.5 cm in the transverse diameter. Mediastinal invasion was considered present if the tumor extended outside the tracheal or bronchial walls. Criteria for esophageal or aortic invasion included contiguity of the tumor with these structures with obliteration of intervening fat planes.

Medical records were reviewed with regard to the clinical presentation and bronchoscopic, surgical, and pathologic findings.

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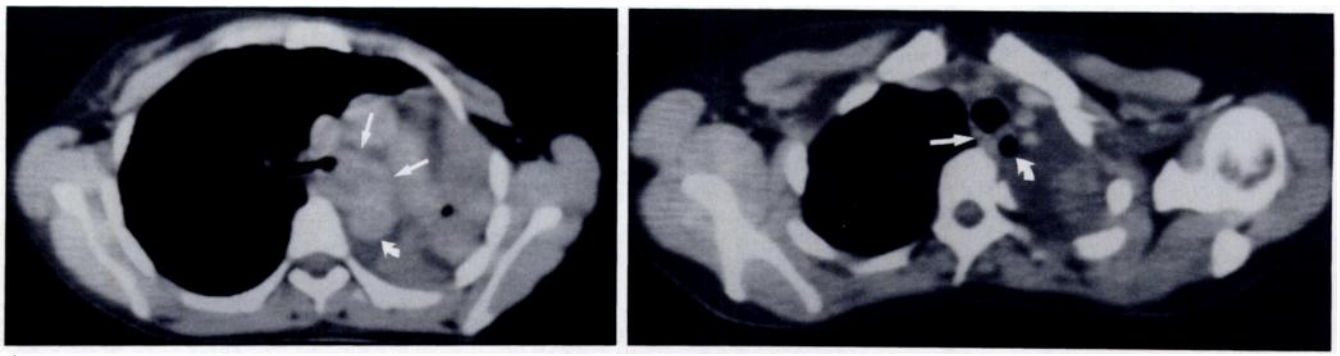

A B

Fig. 1.—**A**, CT image at level of right upper lobe bronchus demonstrates total occlusion of left mainstem bronchus by adenoid cystic carcinoma. There is mediastinal extension (*arrows*) and collapse of left lung with leftward mediastinal shift. No fat plane between descending aorta (*curved arrow*) and tumor is evident. **B**, CT image obtained at level of great vessels in same patient as Figure 1. Adenoid cystic carcinoma (*arrow*) is present between trachea and air-filled esophagus (*curved arrow*). Left lung is collapsed. Because of extensive involvement from subcarinal region to neck, the patient was deemed inoperable.

Results

The patients (five women and one man) ranged in age from 30 to 56 years. Four presented with symptoms suggesting pneumonia, one with hemoptysis, and one with wheezing, suggesting asthma.

The following locations of the adenoid cystic carcinomas were demonstrated on CT scans: the distal trachea in three cases, the midtrachea in one case, and the carina and both main bronchi in one patient; in one patient, the involvement extended from the thoracic inlet to below the origin of both the left and right main bronchi. An intraluminal mass of soft-tissue density was noted in all six cases. Extension through the tracheal wall was a characteristic feature of these tumors. The extraluminal component was identified on CT in every case (Fig. 1). The primary site of involvement was the intrathoracic trachea, but extension into the neck occurred in one patient. CT demonstrated carinal involvement in five of the six cases and tumor extension into the main bronchi in five cases (Fig. 1).

Three patients had radiographic evidence of complete atelectasis of one lung, and one patient had collapse of the right upper lobe. In these instances, CT clearly demonstrated the occluded bronchi (Figs. 1 and 2). CT identified metastases to the pleura in one case (Fig. 3).

The bronchoscopic, surgical, and pathologic findings were correlated with the CT features in five cases. One patient did not have surgical exploration or resection because of an extensive tumor involving the entire thoracic trachea that was demonstrated by both CT and bronchoscopy. Although CT was accurate in determining extension of the tumor into the carina and mainstem bronchi, CT consistently underestimated the degree of longitudinal spread. In the five cases that were surgically explored, CT underestimated the tumor's extent of growth along the trachea (Fig. 4).

CT was highly accurate in the assessment of the extraluminal component of the tumor and the degree of extension into the mediastinum and hilus. However, this was not the case with determination of organ invasion. CT demonstrated loss of fat planes between tumor and mediastinal structures (esophagus, aorta) in five cases (Fig. 1). In four of these cases, the structures were not involved at surgery. Two cases had mediastinal nodal metastases. In each instance, CT failed to demonstrate the nodes that were less than 1.5 cm in size.

Fig. 2.—CT image immediately inferior to carina. Adenoid cystic carcinoma narrows and distorts right upper lobe bronchus (*arrow*). Right upper lobe is collapsed (*open arrow*).

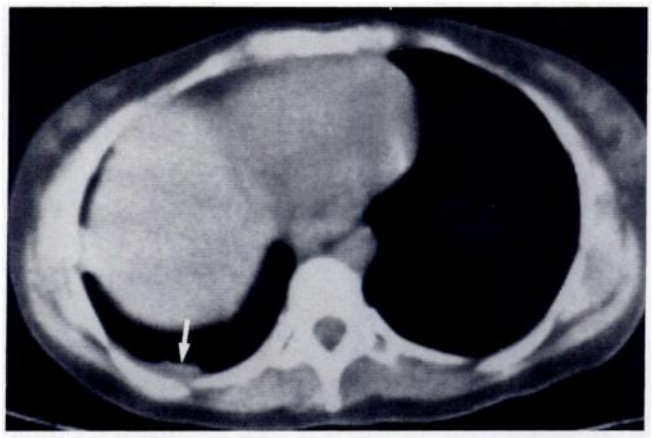

Fig. 3.—CT image shows pleural metastases (*arrow*) from adenoid cystic carcinoma. The lesions were proved by biopsy.

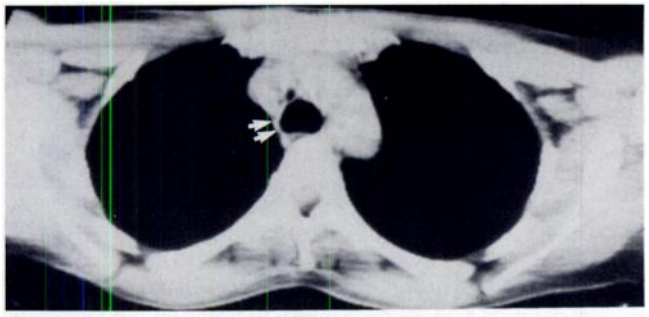

Fig. 4.—CT image just superior to level of right upper lobe bronchus. Right paratracheal tissue (*arrows*) was interpreted as azygos vein. At surgery, this area was involved by adenoid cystic carcinoma.

Discussion

Primary tracheal tumors are uncommon, accounting for less than 0.1% of all deaths due to carcinoma [2]. Most primary tracheal tumors in adults are malignant, with squamous cell carcinoma being most frequent [1]. In a series of 110 primary tracheal tumors seen at the Massachusetts General Hospital, 38 (approximately 35%) were adenoid cystic carcinoma [3]. Unlike squamous cell carcinoma, which occurs predominantly in smokers [5], adenoid cystic carcinoma appears to be unrelated to smoking [6]. There is no gender predilection, and the average age of patients in one series was 47 [7].

Pathologically, the tumor is composed of small epithelial cells arranged in sheets, with fenestration that gives a cribriform pattern [8]. It grows slowly, in both the transverse and longitudinal planes. The tumor may burrow within the tracheal mucosa, thickening the mucosa without producing a distinct mass, and it often involves the entire circumference of the trachea [8]. Adenoid cystic tumor may infiltrate through the fibrous membrane between adjacent cartilage plates into the peritracheal tissue. Perineural or intraneural infiltration, as well as pericardial, great vessel, or pulmonary hilar involvement may occur [8]. Metastasis to regional lymph nodes may be present in 10% of the cases at the time of diagnosis [9]. Distant metastases may occur in the lungs, liver, abdomen, lymph nodes, or bones [4].

Symptoms usually relate to airway obstruction. In the Massachusetts General Hospital series of tracheal tumors, 69% of patients with adenoid cystic carcinoma presented with dyspnea. Hemoptysis occurred in 28% [1]. Wheezing is a frequent symptom in upper airway lesions. Patients may be incorrectly diagnosed and treated for asthma for months or years before the lesion is recognized. Indeed, one of our patients was being evaluated for "asthma" when her tracheal tumor was discovered.

The plain film and conventional tomographic findings in adenoid cystic carcinoma have been described previously [4, 10]. The intraluminal component is usually well visualized by conventional studies, and if the extratracheal component is large, distortion of the normal mediastinal contours may occur. A barium swallow may demonstrate extrinsic esophageal compression or invasion, and thus help define the extratracheal component of the tumor. Fluoroscopy can be used to evaluate tracheal obstruction dynamically. Restriction of vocal cord motion may indicate unsuspected involvement of the larynx or the recurrent laryngeal nerve.

CT is valuable in demonstrating the primary tumor and its extent. In the three cases that presented with total lung atelectasis distal to the tumor, the location of the obstructing lesion was well shown (Fig. 1). Extraluminal growth in the transverse plane, a common feature of adenoid cystic carcinoma, was present in every case and was well demonstrated by CT.

The treatment of adenoid cystic carcinoma involves surgical resection and anastomosis when possible [1, 3]. Criteria for inoperability include excessive longitudinal extent, macroscopic mediastinal nodal metastases, distant metastatic deposits, and direct invasion of contiguous mediastinal structures such as the aorta and the esophagus. Our experience indicates that CT has a definite but limited role in the assessment of these factors. Its greatest usefulness appears to be in the detection of distant metastases. CT visualized a pleural metastatic deposit in the single case that was found to have nonnodal metastases (Fig. 3).

In several of our cases, CT could not predict invasion of local structures. In five cases fat planes between the esophagus and the tumor were not visible on CT, and in all of these cases, the esophagus was found at surgery to be free of invasion. Contrast material was not useful in improving visualization of fat planes between mediastinal tumor and the aorta. Indeed, loss of fat planes has been demonstrated to be an insensitive sign of local invasion in other tumors [11].

In the five cases that underwent surgical exploration, CT underestimated the extent of the tumor in the longitudinal plane. This is not surprising because of the effect of partial volume averaging in 10-mm-thick sections. In addition, adenoid cystic carcinoma may grow submucosally without producing a distinct mass. For this reason, when surgical resection is performed, frozen-section biopsy diagnosis of the resection margins is recommended, because the tumor may extend beyond even visibly clear margins [1]. Conventional tomography may be more accurate in evaluating the longitudinal growth of the tumor because, unlike CT, it is not limited to imaging in the transverse plane [12]. An accurate estimation of tumor length is critical in determining the feasibility of performing a resection, that is, the ability to successfully anastomose the tracheal ends without tension.

CT failed to demonstrate adenopathy in two patients who were found to have lymph nodes positive for tumor at surgery. In one case, the nodes were all less than 1.5 cm in size. Partial volume averaging as well as mediastinal shift due to a collapsed right lung may have contributed to this false-negative CT examination. The size of the positive lymph node in another case was not determined. Its peritracheal location may be responsible for the false-negative CT, because the lymph node may have blended with the mediastinal extension of the tumor. However, in both cases resection was still possible because the metastases were contained within the capsule of the involved nodes.

When surgery is not indicated, usually because of extensive local disease or metastases, radiation therapy is recom-

mended [1, 3, 6]. Because of the tendency of this tumor for late recurrence, the eventual outcome of "curative" surgery is difficult to predict. In the 16 patients treated with surgical resection and reconstruction at Massachusetts General Hospital from 1962 to 1981, 12 are presently free of disease [1]. The remaining three patients died of recurrent tumor, one of which occurred 17 years after the primary resection.

CT is a useful imaging procedure in adenoid cystic carcinoma. It is highly accurate in the assessment of tumor location, extraluminal extension that is not visible on standard radiographs, carinal involvement, and distant metastases. It is therefore recommended in the preoperative evaluation. However, CT is a poor predictor of longitudinal extent and mediastinal organ invasion. Standard tomography, which permits direct imaging in the coronal and sagittal planes, may be better for the assessment of tumor length. MRI, which can produce images in several planes and which can delineate mediastinal fat with great clarity, holds promise for optimal imaging of these lesions.

REFERENCES

1. Grillo HC. Tracheal tumors. In: Choi NC, Grillo HC, eds. *Thoracic oncology*. New York: Raven Press, **1983**:271–278
2. Ranke EJ, Presley SS, Holinger PH. Tracheogenic carcinoma. *JAMA* **1962**;182:519–522
3. Grillo HC. Management of tracheal tumors. *Am J Surg* **1982**;143:697–700
4. Weber AL, Grillo HC. Tracheal tumors. *Radiol Clin North Am* **1978**;16(2):227–246
5. Hajdu SI, Huvos AG, Goodner JT, Foote FW, Beattie EJ Jr. Carcinoma of the trachea. Clinicopathologic study of 41 cases. *Cancer* **1970**;25:1448–1456
6. Richardson DJ, Grover FL, Trinkle JK. Adenoid cystic carcinoma of the trachea. *J Thorac Cardiovasc Surg* **1973**;66:311–314
7. Houston HE, Payne WS, Harrison EG, Olsen AM. Primary cancers of the trachea. *Arch Surg* **1969**;99:132–140
8. Mark EJ. Pathology of tracheal neoplasms. In: Choi NC, Grillo HC, eds. *Thoracic oncology*. New York: Raven Press, **1983**:257–269
9. Pearson FG, Thompson DW, Weissberg D, Simpson WJK, Kergin FG. Adenoid cystic carcinoma of the trachea. *Ann Thorac Surg* **1970**;18:16–29
10. Cleveland RH, Nice CM, Ziskind J. Primary adenoid cystic carcinoma (cylindroma) of the trachea. *Radiology* **1977**;122:597–600
11. Baron RL, Levitt RG, Sagel SS, White MJ, Roper C, Marbarger JP. Computed tomography in the preoperative evaluation of bronchogenic carcinoma. *Radiology* **1982**;145:727–732
12. Shepard JO, Dedrick CG, Shipley RT, McLoud TC. CT of the trachea and carina: A comparison with conventional tomography. *Radiology* **1984**;153P:235 (abstr.)