Esophageal Carcinoma: Pretherapy Staging by Computed Tomography

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Fifty-two patients with proven esophageal malignancy underwent esophagography, computed tomography (CT), esophagoscopy, and/or surgical exploration and resection. On the basis of CT findings, esophageal carcinoma was classified into four stages: stage I, intraluminal mass without esophageal wall thickening; stage II, esophageal wall thickening (greater than 5 mm); stage III, esophageal wall thickening and contiguous spread of tumor into adjacent mediastinal structures such as the trachea, bronchi, aorta, or atrium; and stage IV, any stage with evidence of distant metastatic disease. The stage of esophageal malignancy as determined by CT was correlated with symptoms, location of tumor, esophagography, and surgical findings. Results indicated that CT staging of esophageal carcinoma correlated closely with surgical findings and that local extension, regional adenopathy, and size of tumor mass were better evaluated by computed tomography than by other methods. CT is an accurate method of preoperatively staging esophageal carcinoma, capable of providing staging information heretofore only available by surgical exploration.

Carcinoma of the esophagus is infrequently diagnosed before extraesophageal spread to the mediastinum, abdomen, or liver [1–4]. Due to the advanced stage of disease usually present at the time of diagnosis, survival rates are low and have remained unchanged over the past two decades despite more aggressive surgical and radiation therapy regimens [1, 3, 5–9]. The choice of therapeutic approach depends to a great extent on pretherapy assessment of the stage of the esophageal carcinoma. Plain chest radiography, tomography, barium esophagograms, azygous venography, esophagoscopy, mediastinoscopy, and bronchoscopy have been and are currently used to assess the extent of disease [10–16]. Often, however, these methods have proven to be inaccurate and the degree of spread of an esophageal carcinoma has only been accurately determined at surgery [1, 2, 10, 16].

Computed tomography (CT) routinely displays the anatomy of the esophagus and mediastinum with a high degree of accuracy [17–21]. Normal and pathologic esophageal anatomy have been described [17, 18] and it has been suggested that CT is an accurate method of assessing extraesophageal spread of carcinoma without surgery [18].

This report is a study of the use of computed tomography to stage esophageal carcinoma before therapy in a large group of patients. The impact of CT on the choice of therapeutic approach will be discussed.

Subjects and Methods

Fifty-two patients, 41 men and 11 women, aged 45–84 years (mean, 63.4), were studied from 1978 through June 1980. All patients had primary esophageal carcinoma diagnosed by pathologic examination obtained by endoscopic biopsy (35 patients) and/or surgery (17 patients). All but three patients had upper gastrointestinal radiography and barium esophagography before the computed tomographic examination. All CT scans were per-

Received December 16, 1980; accepted after revision March 5, 1981.

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AJR 136:1051–1056, June 1981
0361–803X/81/1366–1051 $00.00

formed within 3 weeks of endoscopy and/or surgery and all were performed within 4 weeks of institution of appropriate therapy. Computed tomographic scans were obtained using either a GE CT/T whole body scanner (10 mm slice thickness) or a Siemens body scanner (8 mm slice thickness).

Patients were allowed only water by mouth from midnight until the scan was performed in the morning. Computed tomographic scans were taken at 1 cm intervals from the sternal notch to the umbilicus with the patient supine. CT scans of the neck were performed if barium esophagography or endoscopy detected a cervical esophageal lesion. Intravenous infusion of 150 ml of 60% methylglucamine diatrizoate was administered in most patients to better define the mediastinal vascular structures. In some patients, CT scans were also taken during or immediately after a swallow of a 1%–2% solution of Gastrografin or barium sulfate.

All CT scans were evaluated prospectively before surgical exploration or institution of therapy. The esophagus was analyzed for: (1) esophageal wall thickness, (2) length of esophageal mass, (3) maximum diameter of tumor, (4) presence of dilatation of the esophagus above the lesion, (5) location (central or eccentric) of air or contrast material with the esophageal lumen, and (6) fistula. The mediastinum, lungs, and abdomen were studied for evidence of direct invasion or metastasis. The criteria used to determine extraesophageal tumor extension were: (1) loss of tissue fat planes between esophageal mass and contiguous mediastinal structures, (2) enlargement of lymph nodes in the above-mentioned sites, (3) contrast leak into paraesophageal structures, (4) mass extension into the trachea or bronchi, and (5) presence of hepatic, pulmonary, or abdominal metastasis. Extension was judged to be present only when the combination of CT findings indicated unequivocal tumor extension. Our method, therefore, would have tended to underestimate the incidence of direct tumor extension.

On the basis of CT findings, esophageal carcinoma was classified into four stages: *stage I*, intraluminal mass without esophageal wall thickening and no mediastinal extension or metastasis; *stage II*, thickening of esophageal wall to greater than 5 mm, but no evidence of metastatic disease or mediastinal tumor extension (fig. 1); *stage III*, thickening of the esophageal wall with direct extension into the surrounding tissue; local or regional mediastinal lymphadenopathy may or may not be present; no evidence of direct tumor spread to the skeletal structures or distant metastasis (fig. 2); and *stage IV*, any tumor stage with distant metastatic disease (fig. 3). The CT findings and staging were correlated with clinical, surgical, and pathologic findings.

Results

The variety of symptoms due to esophageal carcinoma and/or its complications included dysphagia, weight loss, hematemesis, abdominal pain, and hoarseness; dysphagia and weight loss were the most common. Staging esophageal carcinoma on the basis of clinical symptoms was not successful because similar symptoms were found in patients with all stages of esophageal malignancy. Patients experiencing weight loss greater than 5 kg more frequently had stage III or IV disease, but dysphagia was nonspecific.

Forty-nine patients had squamous cell carcinoma, three adenocarcinoma. The three patients with adenocarcinoma had lesions in the mid-esophagus and no evidence of gastric carcinoma. Tumors were most frequently located in the mid-esophagus (26 patients), but examples of esophageal malignancy were found in the upper third (13 patients) and the distal part (13 patients) of the esophagus. Stage II, III, and IV esophageal malignancies were found in the mid and lower third of the esophagus; however, all esophageal carcinomas located in the upper third of the esophagus were stage III or IV malignancies.

Esophagograms in 49 patients characterized the esoph-

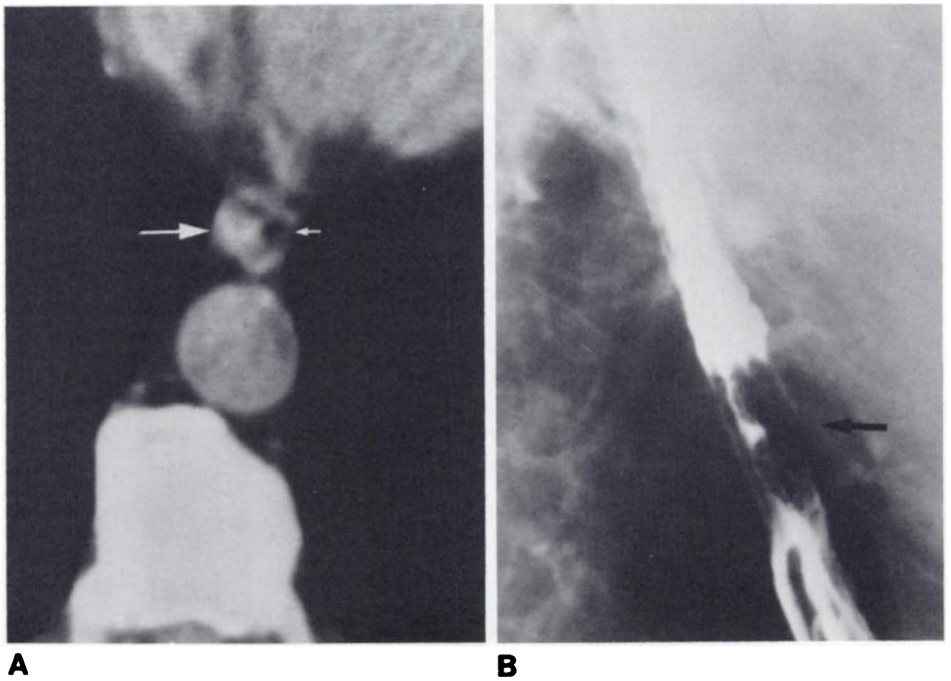

Fig. 1.—Stage II esophageal carcinoma. A, CT scan. Focal thickening of right lateral esophageal wall (*large arrow*) which causes esophageal lumen (*small arrow*) to have eccentric position. Fat planes surrounding esophagus are normal. B, Esophagogram. Focal nonobstructing mass (*arrow*) in distal third of esophagus.

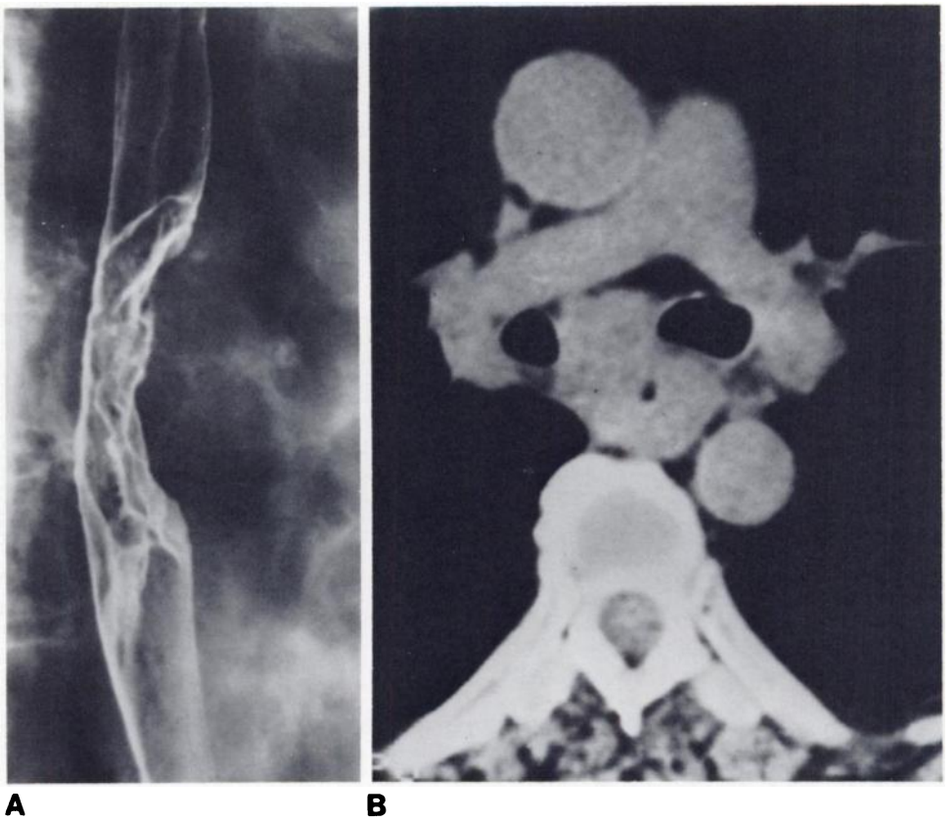

Fig. 2.—Stage III esophageal carcinoma. **A**, Esophagogram. Large infiltrating carcinoma of mid esophagus. **B**, CT scan through esophageal tumor. Thickened esophageal wall, eccentric lumen, and invasion into subcarinal space. Tumor mass obliterates fat plane between esophagus and bronchial wall.

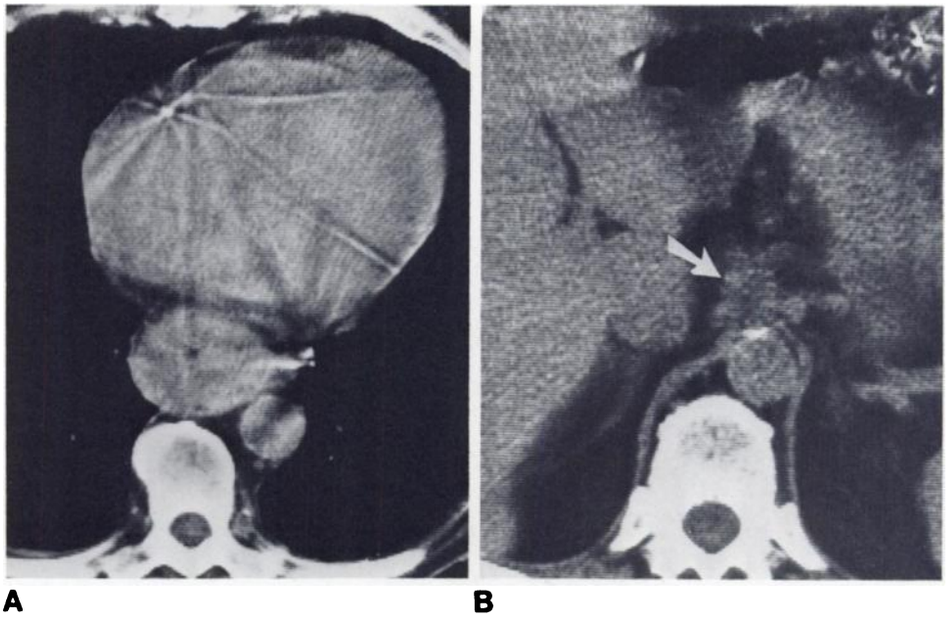

Fig. 3.—Stage IV esophageal carcinoma. **A**, Marked thickening of wall of esophagus. **B**, Scan through upper abdomen. Spread of tumor to celiac lymph nodes (*arrow*).

ageal malignancy as infiltrating in 28 (57%), polypoid in 13 (27%), and ulcerating in four (8%) patients. Four patients (8%) had small esophageal abnormalities that affected only part of the esophageal wall (fig. 1B). In three of these patients, the esophageal abnormallity was detected as an "incidental" finding on a CT examination of the chest in patients without esophageal symptomatology (fig. 1A). There was lack of correlation between any particular radio-

graphic pattern of esophageal carcinoma detected on esophagography and stage of esophageal carcinoma except for the three patients with very small esophageal carcinomas who all had stage II esophageal malignancy.

Computed tomography revealed focal thickening of the esophageal wall in all 52 patients with esophageal malignancy. Computed tomography detected direct extension of esophageal carcinoma into several mediastinal structures and identified metastatic disease to the liver, adrenal gland, lung, and cervical, retrocrural, celiac, retroperitoneal, and mediastinal lymph nodes (table 1). The length of esophageal carcinoma as judged by CT was 1.0–14 cm (5.7 cm average) and the maximum diameter of the tumor was 0.8–5 cm (3.2 cm average). The mean length of tumor measured on barium esophagography was 5.8 cm (1–13 cm). Although the mean tumor lengths measured on CT and esophagography were almost identical, the values were sometimes discordant by as much as 2–3 cm. As expected, CT seemed better able to determine submucosal extent while barium esophagography better delineated mucosal abnormalities. An eccentrically positioned esophageal lumen was found in 34 (65%) patients examined by CT. In the remaining 18 patients, the esophageal lumen could not be identified. In all of these patients, the esophagogram and CT scans revealed evidence of high grade esophageal obstruction with dilatation of the esophagus proximal to the tumor.

On the basis of CT findings, esophageal malignancy was classified as stage I in no patients, stage II in seven, stage III in 33, and stage IV in 12. Of the 13 carcinomas in the upper third of the esophagus, 10 were classified as stage III, three as stage IV. Middle esophageal tumors were classified as stage II in two, stage III in 20, and stage IV in four patients. Lower esophageal carcinoma in 13 patients was classified as stage II in five (38%), stage III in three (24%) and stage IV in five (38%) patients.

Of the 17 patients who underwent surgery for diagnosis, staging, and/or therapy, CT had classified four patients as having stage II esophageal carcinoma, 10 as stage III, and three as stage IV. In every instance, surgery confirmed the CT stage of esophageal malignancy and verified mediastinal invasion of adjacent structures and the presence of mediastinal adenopathy. Thus, we found the preoperative CT staging of esophageal carcinoma to correlate with the findings at surgery in all 17 patients who had surgery. CT classified 32 of the remaining 35 patients as having stage III or IV disease and all patients were treated with radiation therapy.

TABLE 1: **Extraesophageal Extent of Esophageal Carcinoma on CT**

Direct Invasion of Adjacent Organs		Metastatic Disease	
Trachea	24	Liver	3
Carina	12	Adrenals	1
Bronchi:		Pleura	2
Right, main	6	Lung	1
Left, main	14	Lymph nodes:	
Fistula	2	Right paratracheal	5
Left atrium	8	Left paratracheal	3
Aorta	17	Pulmonary aortic window	4
Pulmonary vessels:		Pretracheal space	3
Artery	3	Cervical	1
Veins	2	Retrocrural	1
Azygous vein	3	Celiac	7
Vertebra	1	Paraaortic, caval	3
		Jugular	2
		Superior mediastinum	1

Fig. 4.—Spread of esophageal carcinoma (*arrow*) to involve left mainstem bronchus, carina, and descending aorta (a).

Discussion

Institution of appropriate therapy for esophageal carcinoma depends in part on accurate diagnosis and staging. While not used as the initial diagnostic procedure, CT has been reported to be a rapid, noninvasive method of accurately staging esophageal carcinoma [18]. In this, the largest series reported to date, preoperative CT staging correlated exactly with surgical findings in every case that had a surgical procedure. In all patients, CT provided information about length and diameter of tumor, lymph node involvement, and metastatic disease vital in determining resectability and in radiation therapy planning.

Computed tomographic scans were abnormal in all 52 patients with esophageal carcinoma. Most commonly found were focal esophageal wall thickening which produced an eccentrically positioned esophageal lumen (fig. 1) and large esophageal masses almost obliterating the esophageal lumen (fig. 3). Computed tomography accurately demonstrated esophageal carcinoma invading the trachea and bronchi (figs. 4 and 5), left atrium, aorta (fig. 4), and pulmonary arteries and veins. Metastatic involvement of the mediastinal and abdominal (fig. 3) lymph nodes, liver, and adrenal glands was clearly displayed by CT and allowed precise preoperative staging of esophageal carcinoma not obtainable by any other single noninvasive diagnostic method.

Our results indicate CT should be routinely used before surgery or radiation therapy in patients with esophageal carcinoma. Esophageal carcinoma is believed to be inoperable for cure when there is bronchoscopic or mediasti-

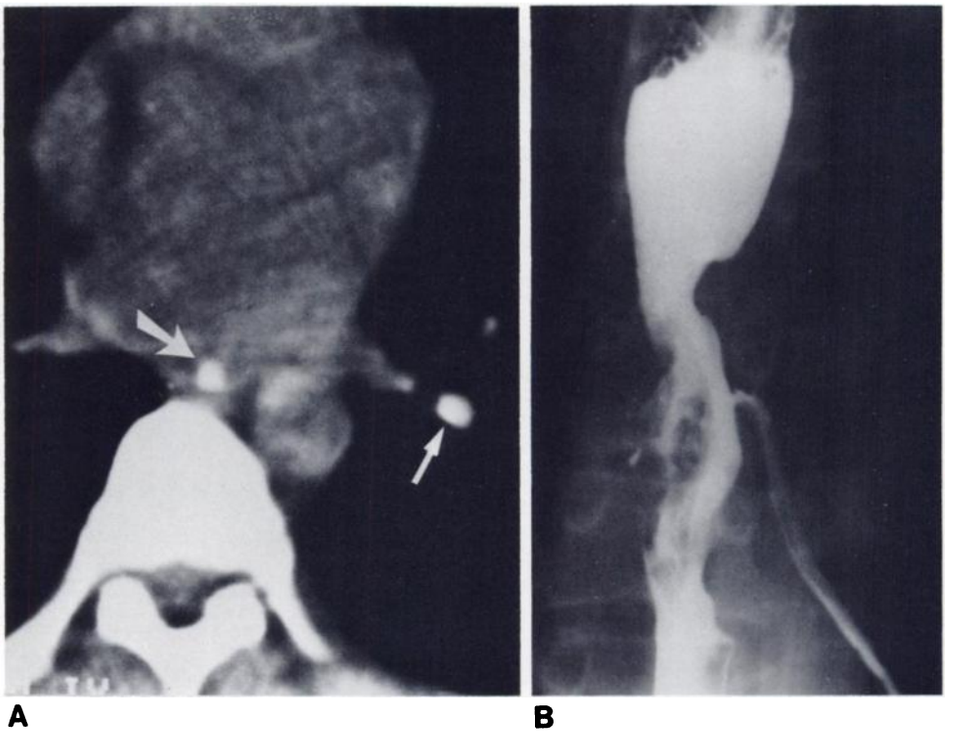

Fig. 5.—Patient with esophagobronchial fistula. **A**, CT scan after swallow of 2% barium sulfate. Esophageal lumen (*large arrow*) and left bronchial tree (*small arrow*) opacified by barium. **B**, Esophagogram. Esophagobronchial fistula.

noscopic evidence of direct invasion of the trachea or bronchi, or spread of tumor to lymph nodes [1, 2, 10, 16]. Due to the imprecision of clinical methods of detecting extraesophageal spread of tumor [5], many patients undergo surgical exploration to determine resectability of esophageal carcinoma [2]. CT demonstrated direct invasion of mediastinal structures, mediastinal lymph node enlargement, and/or metastatic disease below the diaphragm in 45 (87%) of 52 patients studied. The high accuracy rate of CT in detecting and defining extraesophageal extension of esophageal carcinoma should allow a more accurate preoperative determination of resectability. If CT reveals no evidence of extraesophageal spread of a patient's esophageal carcinoma and the lesion is located in an area amenable to surgery, a curative surgical procedure may be attempted. This was done in four of the seven patients judged to have stage II esophageal malignancy and in each case the tumor could be completely resected and no evidence of tumor spread was found. If CT defines an esophageal malignancy that is judged to be inoperable, the assessment of location, extent, and volume of tumor to be treated will allow the planning of an optimum regimen of radiation therapy.

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