The assessing the left bronchial invasion of esophageal cancer in computed tomography

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Abstract

Background and aims: The prognosis of esophageal squamous cell carcinoma varies according to the degree of invasion of the tumor in the organ wall. When the trachea and the main bronchus are involved in esophageal carcinoma, the disease is classified as incurable and the mortality is lower than that for patients who can be treated with curative surgery.

To evaluate the carcinoma invading the trachea and main bronchus, retrospectively, we investigated computed tomography (CT) findings.

Methods: Of 74 patients with or without proven tracheobronchial involvement who underwent thoracotomy for esophagectomy and Surgery disclosed tumor invasion in pericardium, aorta, pleura, trachea, left main bronchus and parenchyma. Ten patients were not operated upon but exhibited invasion to respiratory tract by broncho-fiber scope.

Results: Lt. main bronchus (NMS angle) were statistically significant in patients with and without invasion. ($P < 0.05$)

Conclusion: It is our conclusion that preoperative evaluation by CT plays an important role whether the tumor is resectable or not.

Introduction

Patients with esophageal carcinoma have a poor prognosis because many esophageal tumors are detected at advanced stages. Many cases of esophageal carcinoma involving the trachea or main bronchus are unresectable or resected with high risk. Preoperative diagnosis to determine possible tumor invasion to a major airway is therefore important.

Numerous reports have described the usefulness of CT in the preoperative staging of esophageal carcinomas [1-3]. Several authors have been disappointed by its poor sensitivity and accuracy [4,5]. Vilgrain *et al.* reported that endoscopic sonography was superior to CT, and many authors reported broncho-fiber scope or ultrasonography were useful for evaluating cancer invasion into the tracheal bronchus [6]. Takashima *et al.* reported that magnetic resonance imaging (MRI) and CT had nearly the same accuracy in predicting resectability of tumors in patients with esophageal carcinoma [7].

But CT is a popular method to evaluate the invasion of major airways. Matsubara *et al.* mentioned that CT and broncho-fiber scope played a significant role in selecting resectable patients [8]. Picus *et al.* [9] reported that the angle to aorta was useful to evaluate the invasion to aorta. To evaluate the carcinoma invading the trachea, main bronchus and aorta we analyzed 6 matters including the angles and distance from the center of the esophageal lumen, the sectional area and the diameter of the esophagus in CT, retrospectively.

Materials and methods

Cases

We analyzed 74 patients (male: female 59:15) with thoracic esophageal carcinoma who had undergone radical esophagectomy at the Nippon Medical School Hospital or Nippon Medical School, Chiba Hokusoh Hospital between January 1994 and December 2005. The median age is 61.4 years old ranged from 41 to 82 years (Table 1).

CT Scan

All patients had CT scans of the neck, chest, and abdomen. Ten millimeter continuous scans were obtained in areas from the neck to the bottom of the liver. The CT scans were performed using intravenous contrast medium. 6 matters were investigated via CT (computed tomography) for findings of tracheo-bronchial involvement.

Results

We analyzed 6 matters in regard to the following criteria: the sectional area of tumor(1), distance from the center of the esophageal

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lumen to aorta (2), that from the left main bronchus or trachea (3or3'), diameter (4), angles between tumor and aorta (Picus angle) (5), lt. main bronchus or trachea (6or6') in CT shown in Figure 1a-1c.

We analyzed the frequencies of tumors in the 6 matters via CT (Figure 2-5). The patients were divided into 2 groups; involvement of other organs (t4) and non-involvement (t3), and also separated into the 2 groups; involvement to other organs (t4) and non-involvement (t3) based on the pathological findings after surgery.

We compared the frequencies of tumors in the 6 matters of both groups (t4 and t3). In the sectional area of the tumor (1) (Figure 2), diameter (4) (Figure 3), Picus angle (5) (Figure 4), angles of lt. main bronchus (NMS angle) (Figure 5), the frequencies in group t4 tended to be higher than that of t3.

Table 1. Clinicopathological findings of patients with esophageal cancers. (n = 85) analyzed.

Sex	No. of patients	
	Male	Female
Age	68	17
Clinical depth	T4	~T3
Pathological depth	t4	~t3
Ope	+	-
	74	11

Figure 1. The distance from the internal lumen of esophagus to aorta(2), left main bronchus or trachea (3or3'), diameter(4), Picus angle(5), angles between tumor and lt. main bronchus (6)were showed in CT. (1a) The sectional area of tumor(1) (1b) and angles between tumor and trachea (6')were shown in CT (1c).

Figure 2. The frequencyof tumor involvement to other organs (t4) in the sectional area of tumor tended to be higher than non-involvement(t3).

We compared CT findings (t4 and t3) and surgical-pathological findings (t4 and t3). There were significant differences of Picus angle and angles of lt. main bronchus (NMS angle) between the 2 groups by statistical analysis. ($P < 0.05$) There were no significant differences in other matters.

The criteria is as follows: (1) aortic infiltration diagnosed the existence of an angle greater than 90 degrees between tumor and aorta (2) Its main bronchus infiltration was diagnosed when the tumor developed an intimate contact with the lt. main bronchus that was greater than 135 degrees. Sensitivity, specificity and accuracy of (1) were 71%, 77% and 67%, respectively and those of (2) were 100%, 85 % and 75%, respectively (Table 2).

Figure 3. The frequency of group t4 in diameter tended to be higher than that of t3.

Figure 4. The frequency of group t4 in Picus angle tended to be higher than that of t3.

Figure 5. The frequency of group t4 in angles of lt. main bronchus tended to be higher than that of t3.

Table 2. Sensitivity, specificity and accuracy of Lt.main bronchus and aorta infiltration by CT.

	Sensitivity	Specificity	Accuracy
Picus angle	71%	77%	67%
Angles of Lt.main bronchus	100%	85%	75%

Discussion

Many reports emphasize that the role of CT in ascertaining the stage of esophageal carcinomas. Ascertaining the extent of infiltration of the tumor and lymph node metastases in esophageal carcinomas should influence the therapeutic method.

Picus *et al.* defined the tomographic criteria for incurability of tumor invasion of aorta, trachea, and main bronchus in regard to the presence of compression or displacement of these organs by the esophageal mass. Picus angle was particularly useful to evaluate the infiltration to the aorta [9].

Halvorsen and Thompson established and classified the criteria “normal displacement compression” (in which the usual anatomic axis of trachea and bronchi is altered by the adjacent mass) [10,11]. Takashima *et al.* and Rasch *et al.* demonstrated excellent results with CT in the evaluation of tumors with regard to the involvement of the respiratory tree [7,12].

Doyle *et al.* reported scanning the patient in the prone position potentially improved the capacity for assessing the contact between tumor and the aorta or left main bronchus. Wayman mentioned 3 cases where aortic invasion was downstaged by performing the scan in supine position [13].

On the other hand, other studies have obtained very poor results with CT in the evaluation of esophageal carcinoma [14].

Many investigators reported that in staging the depth of tumor growth, endoscopic ultrasonography was significantly more accurate [6]. Broncho-fiber scope allows the direct visualization of changes, such as hyperemia of the mucosa, compression of the airway, and invasion itself, and is essential for the evaluation of the respiratory tree in esophageal cancer carcinoma. But Halvorsen *et al.* [10] summarized a statistically significant advantage for spiral CT over bronchoscopy in advanced esophageal masses with a sensitivity of 88.3%.

Takashima *et al.* concluded that MR and CT have nearly the same accuracy in predicting resectability of tumors in patients with esophageal carcinoma [7].

Endoscopic ultrasonography was an excellent method for evaluating t3 or t4, but sometimes the endoscopy cannot pass the tumor because of stenosis caused by esophageal tumor especially in the case of the tumor extending beyond adventitia. CT was applied to all the patients even when the esophageal lumen was stenotic. Schimer *et al.* described no statistically significant difference between CT and broncho-fiber scope because an accuracy of 85.1% was obtained with regard to impingement, displacement and invasion of trachea and bronchus [1]. Lehr *et al.* also mentioned poor results with CT in the evaluation of esophageal carcinoma due to small sample size and that one-third of the cases had trans-mediastinal esophageal resection, that were unhelpful in evaluating invasion [15]. The larger the tumor the greater the diagnostic capacity of CT, justifying the accuracy of 85.1% obtained [16-18].

Another problem is evaluation by surgical technique. A transmediastinal esophageal dissection technique is not available in

evaluating tumors because dissection at the superior mediastinum is performed without direct vision [1,18].

It is our conclusion that esophagectomy is preferable when the tracheo-bronchial involvement is assessed as technically, resectable and preoperative assessment by CT plays an important role whether the tumor is resectable or not.

References

- Schirmer CC, Osvaldt AB, Gurski RR, Xavier RG, Ilha DO, et al. (1999) Efficacy of computed axial tomography in the evaluation of the involvement of the respiratory tract in patients with squamous cell carcinoma of esophagus. *Dis Esophagus* 12: 196-201. [Crossref]
- Søndenaa K, Skaane P, Nygaard K, Skjennald A (1992) Value of computed tomography in preoperative evaluation of resectability and staging in oesophageal carcinoma. *Eur J Surg* 158: 537-540. [Crossref]
- Helmlinger H (1999) CT for local staging of esophageal cancer. *Dis Esophagus* 12: 202-204. [Crossref]
- Botet JF, Lightdale CJ, Zauber AG, Gerdes H, Urmacher C (1991) Preoperative staging of esophageal cancer: comparison of endoscopic US and dynamic CT. *Radiology* 181: 419-425. [Crossref]
- Scotiniotis IA, Kochman ML, Lewis JD, Furth EE, Rosato EF, et al. (2001) Accuracy of EUS in the evaluation of Barrett's esophagus and high-grade dysplasia or intramucosal carcinoma. *Gastrointest Endosc* 54: 689-696. [Crossref]
- Vilgrain V, Mompont D, Palazzo L, Menu Y, Gayet B, et al. (1990) Staging of esophageal carcinoma: comparison of results with endoscopic sonography and CT. *AJR Am J Roentgenol* 155: 277-281. [Crossref]
- Takashima S, Takeuchi N, Shiozaki H, Kobayashi K, Morimoto S, et al. (1991) Carcinoma of the esophagus: CT vs MR imaging in determining resectability. *AJR Am J Roentgenol* 156: 297-302. [Crossref]
- Matsubara T, Ueda M, Nakajima T, Nakagawa K, Yamashita T, et al. (1995) Can esophagectomy cure cancer of the thoracic esophagus involving the major airways? *Ann Thorac Surg* 59: 173-177. [Crossref]
- Picus D, Balfe DM, Koehler RE, Roper CL, Owen JW (1983) Computed tomography in the staging of esophageal carcinoma. *Radiology* 146: 433-438. [Crossref]
- Halvorsen RA Jr, Thompson WM (1987) Computed tomographic staging of gastrointestinal tract malignancies. Part I. Esophagus and stomach. *Invest Radiol* 22: 2-16. [Crossref]
- Thompson WM, Halvorsen RA, Foster WL Jr, Williford ME, Postlethwait RW, et al. (1983) Computed tomography for staging esophageal and gastroesophageal cancer: reevaluation. *AJR Am J Roentgenol* 141: 951-958. [Crossref]
- Rasch L, Brenøe J, Olesen KP (1990) Predictability of esophagus- and cardiatumor resectability by preoperative computed tomography. *Eur J Radiol* 11: 42-45. [Crossref]
- Doyle GJ, Simpson W (1994) Technical report: prone scanning in the CT assessment of oesophageal carcinoma. *Clin Radiol* 49: 209-210. [Crossref]
- Wayman J, Chakraverty S, Griffin SM, Doyle GJ, Keir MJ, et al. (2001) Evaluation of local invasion by oesophageal carcinoma- a prospective study of prone computed tomography scanning. *Postgrad Med J* 77: 181-184. [Crossref]
- Lehr L, Rupp N, Siewert JR (1988) Assessment of resectability of esophageal cancer by computed tomography and magnetic resonance imaging. *Surgery* 103: 344-350. [Crossref]
- Lefor AT, Merino MM, Steinberg SM, Dwyer A, Roth JA, et al. : Computerized tomographic prediction of extraluminal spread and prognostic implications of lesion width in esophageal carcinoma. *Cancer* 62: 1287-1292.
- Wurtz A, Quandalle P, Chambon JP, Saudemont A, Chastanet P, et al. (1990) [Correlation of diameters measured by x-ray computed tomography and intraparietal extension of squamous cell carcinoma of the thoracic esophagus. Apropos of 101 anatomoradiologic comparisons]. *J Chir (Paris)* 127: 63-67. [Crossref]
- Legmann P, Marmuse JP, Rjeb S, Benacerraf R (1991) Preoperative computed tomography for transhiatal esophagectomy. *Invest Radiol* 26: 987-991. [Crossref]

19. Riedel M, Hauck RW, Stein HJ, Mounyam L, Schulz C, et al. (1998) Preoperative bronchoscopic assessment of airway invasion by esophageal cancer: a prospective study. *Chest* 113: 687-695. [[Crossref](#)]
20. Van den Hoed RD, Feldberg MA, van Leeuwen MS, van Dalen T, Obertop H, et al. (1997) CT prediction of irresectability in esophageal carcinoma: value of additional patient positions and relation to patient outcome. *Abdom Imaging* 22:132-137. [[Crossref](#)]