Transthoracic Esophagectomy With Radical Mediastinal and Abdominal Lymph Node Dissection and Cervical Esophagogastrostomy for Esophageal Carcinoma

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Background. **Several techniques for esophageal resection have been reported. This study examines the morbidity, mortality, and early survival of patients after transthoracic esophagectomy for esophageal carcinoma using current staging techniques and neoadjuvant therapy. The technique includes right thoracotomy, laparotomy, and cervical esophagogastrostomy (total thoracic esophagectomy) with radical mediastinal and abdominal lymph node dissection.**

Methods. **Three hundred forty-two patients had surgery for esophageal carcinoma between 1989 and 2000 at our institution. Two hundred fifty consecutive patients had esophagectomy using this technique. Kaplan-Meier curves and univariate and multivariate analyses were performed by postsurgical pathologic stage.**

Results. **Median age was 62.7 years (31 to 86 years). Fifty-nine were female. Eighty-one percent (202) had induction chemotherapy (all patients with clinical T3/4 or N1). Early postoperative complications included recurrent laryngeal nerve injury (14% [35]), chylothorax (9%, [22]), and leak (8%, [19]). Median length of stay was 13 days (5 to 330 days). In-hospital or 30-day mortality was 3.6% (9). Overall survival at 3 years was 44%; median survival was 25 months, and 3-year survival by posttreatment pathologic stage was: stage 0 (complete response) (n = 60), 56%; stage I (n = 32), 65%; stage IIA (n = 67), 41%; stage IIB (n = 30), 46%; and stage III (n = 49), 17%. Mean follow-up was 24 months (SEM 1.6, 0 to 138 months). Five patients with tumor in situ, 6 patients with stage IV disease, and 1 patient who could not be staged (12 pts) were excluded from survival and multivariate calculations. In univariate and different models of multivariate analysis, age more than 65 years, posttreatment T3, and nodal involvement were predictive of poor survival. For univariate analysis, $p = 0.002$, $p = 0.004$, $p = 0.02$, respectively; for multivariate analysis, $p = 0.001$, $p = 0.003$, $p = 0.02$, respectively.**

Conclusions. **Total thoracic esophagectomy with node dissection for esophageal cancer appears to have acceptable morbidity and mortality with encouraging survival results in the setting of neoadjuvant therapy. Patients who show complete response after induction chemoradiotherapy appear to have improved long-term survival.**

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Over the last 20 years, esophageal adenocarcinoma has been the most rapidly increasing cancer in incidence [1]. The number of cases estimated in 2001 is 13,200 [2]. Despite all treatment strategies, 5-year survival is approximately 10% for this disease [3]. Surgical resection is the standard treatment in early-stage esophageal carcinoma. Multimodal treatment including neoadjuvant chemoradiotherapy with surgery is a common approach for locally advanced esophageal carcinomas in many centers.

Esophagectomy is a technically challenging operation. The choice of surgical approach depends on the location of the tumor, the length of disease extension, adherence to surrounding structures, the use of induction therapy, the concern for postoperative reflux, the planned extent of lymphadenectomy, and the preference of the surgeon. Two techniques are most commonly utilized, a transthoracic esophagectomy (Ivor-Lewis) and a transhiatal esophagectomy. The first combines a laparotomy with right thoracotomy and intrathoracic anastomosis [4]. A transhiatal esophagectomy, first performed in 1936 and reintroduced in the 1970s, involves a laparotomy with blunt dissection of the thoracic esophagus and a cervical anastomosis [5]. Since 1989 in our institution, we have performed a transthoracic esophagectomy with cervical esophagogastric anastomosis (total thoracic esophagectomy with node dissection), which combines the advantages of both transhiatal and transthoracic approaches [6, 7]. Our technique is a modification of McKeown's tech-

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Table 1. Patient Characteristics (n = 250)

Median age (years)		62.4 (31–86)
Gender	Male/female	193/57
Histology	Adenocarcinoma	68%
	Squamous cell carcinoma	31%
	Undifferentiated	1%
Location	Upper third	4%
	Middle third	18%
	Distal third	78%
History of esophageal disease	Barrett's esophagus	30%
	Hiatal hernia	10%

nique described in 1976 [8]. In our approach, an initial right thoracotomy is performed with complete esophageal dissection and resection en bloc with all mediastinal and abdominal lymph nodes. A laparotomy and cervical anastomosis completes the operative procedure [6].

The purpose of this study was to examine morbidity, mortality, and early survival after total thoracic esophagectomy with node dissection in a consecutive series of patients with esophageal carcinoma in the current era.

Patients and Methods

Between March 1989 and July 2000, 342 patients with esophageal carcinoma underwent surgery at The Brigham and Women's Hospital. In 250 consecutive patients, a total thoracic esophagectomy, abdominal and thoracic radical lymph node dissection, jejunostomy tube placement, and cervical esophagogastrostomy were performed (Table 1). The remaining 92 patients underwent surgery with other techniques such as transhiatal esophagectomy, Ivor-Lewis esophagectomy, colon interposition, and a left thoracoabdominal approach. The type of technique performed was determined by pertinent factors such as the extent of tumor, history of prior surgery, and purpose of operation. All patients deemed to have potentially curable esophageal carcinoma and without anatomic contraindication underwent our total thoracic esophagectomy and node dissection. A retrospective chart review was done for the 250 patients who underwent resection using this approach. These patients form the cohort of our study.

All 250 patients had a preoperative radiographic metastatic screen, which included chest, abdominal, and head computerized tomography. Sixty-six percent (165 of 250) had staging procedures. In 55% (138 of 250), a limited laparatomy or laparoscopy was done for lymph node sampling, and if the patient was to have induction therapy, a jejunostomy tube for enteral support and a permanent central intravenous line (Bard Access Systems, Salt Lake City, UT) were inserted. In 26% (64 of 250) of the patients, thoracoscopy was performed to stage the tumor including the sampling of periesophageal lymph nodes. Thirty-four percent (86 of 250) of the patients had an endoscopic ultrasonography (EUS). In 37% (93 of 250), only one of these staging procedures was used; in 29% (72 of 250), multiple modalities were used. During the study period, several treatment protocols were in use and account for the variability in the number of procedures that each patient underwent.

Eighty-one percent of patients (202 of 250) received neoadjuvant treatment. Seventy-eight percent (194 of 250) received combination chemoradiotherapy; the remaining 8 patients received one or the other. In general, the chemotherapy was two cycles of 5-fluorouracil and cis-platinum. Radiation was given concurrently to 50.4 Gy. The type of induction therapy was based on factors such as age, clinical stage of disease, and physiologic capacity, and the cooperative decision was made by the oncologist and the surgeon.

Staging of the patients was done according to the postsurgical pathology report using the TNM system. Follow-up was complete in 98% (244 of 250) of the patients. The patient follow-up data were obtained through hospital records, office charts, and contact with primary care physicians. Six patients were lost to follow-up, and they were censored as alive at the date of last follow-up.

Surgical Technique

Our technique has been described previously [6]. Routine bronchoscopy and esophagogastroduodenoscopy (EGD) are performed in the operating room. Because most of our patients receive neoadjuvant chemoradiation, preoperative EGD is valuable and provides information on response to therapy and the adequacy of the

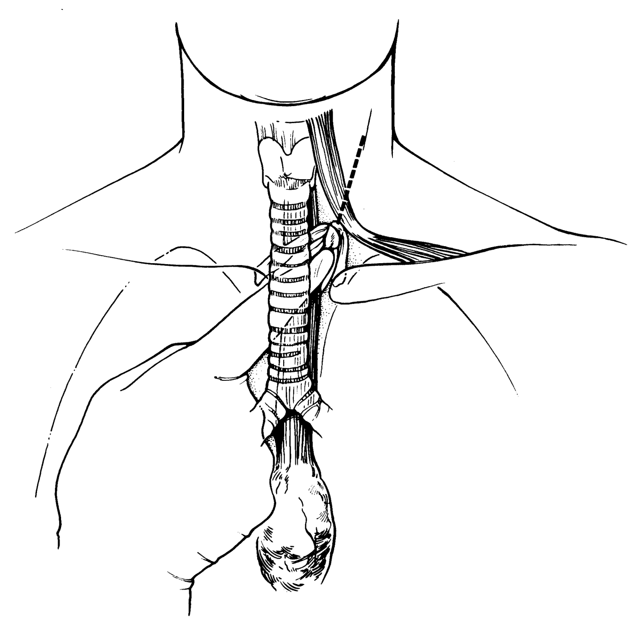


Fig 1. The knotted Penrose drain is pushed up through the thoracic inlet and left to lie beneath the omohyoid muscle on the left side of the neck. (Reprinted with permission of the McGraw-Hill Companies from Swanson SJ, Sugarbaker DJ. The three-hole esophagectomy: The Brigham and Women's Hospital approach (Modified McKeown Technique). Chest Surg Clin North Am 2000;10:531–52 [6]).

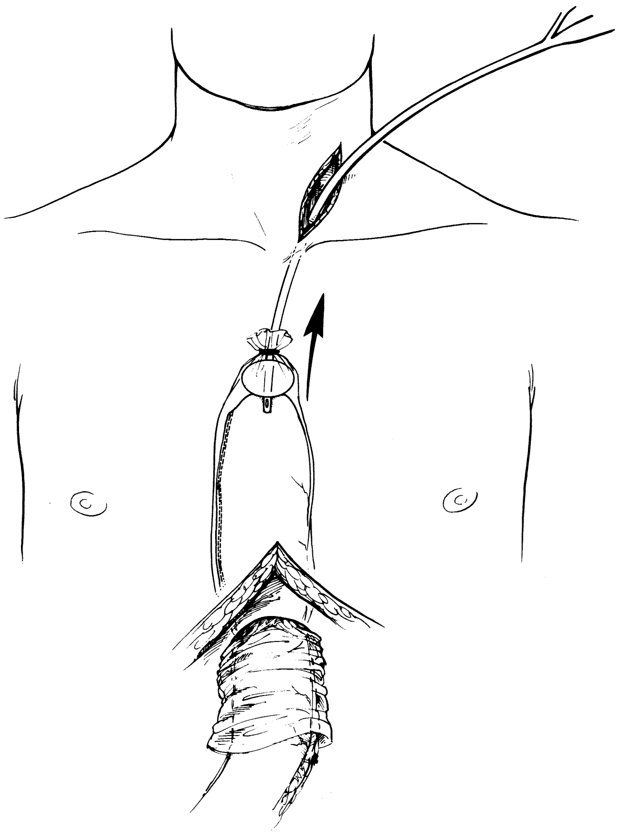


Fig 2. *The gastric conduit is atraumatically pulled through the posterior mediastinum into the cervical wound. (Reprinted with permission of the McGraw-Hill Companies from Swanson SJ, Sugarbaker DJ. The three-hole esophagectomy: The Brigham and Women's Hospital approach (Modified McKeown Technique). Chest Surg Clin North Am 2000;10:531–52 [6].)*

surgical margin. Bronchoscopy rules out the presence of airway involvement. A serratus-sparing, right posterolateral thoracotomy is done through a limited skin incision, and the esophagus is mobilized. All intrathoracic lymph nodes (stations 1, 2, 4, 7, 8, 9, 10, 15, according to the UICC system, 1987) [9] are removed with the specimen. Once the dissection level reaches the thoracic inlet, a Penrose drain is knotted and pushed up into the left neck (Fig 1) [6]. A second Penrose drain is knotted and passed into the peritoneal cavity. A single chest tube is placed and the chest is closed.

The patient is repositioned supine, and an upper midline laparotomy is performed. The Penrose drain is grasped and placed on traction to facilitate mobilization of the stomach, division of the short gastric vessels, and mobilization of duodenum (Kocher maneuver); a pyloromyotomy or single-layer Heineke-Mikulicz type pyloroplasty is performed. The left gastric pedicle is divided with a 30-mm endovascular stapler (US Surgical Corporation, Norwalk, CT). All paraesophageal and celiac axis lymph nodes (stations 16, 17, 18, 19, 20) [9] are mobilized with the specimen.

An 8-cm incision is made in the left neck. The sternocleidomastoid muscle is mobilized laterally; the previously placed Penrose drain is grasped and placed on gentle traction. The esophagus can be adequately mobilized. This maneuver diminishes the risk of injury to the recurrent laryngeal nerves. The esophagus is divided. A No. 2 silk is attached to the distal end of the divided esophagus, which is then delivered down the posterior mediastinum and into the abdomen. Next, an arthroscopic camera bag is secured to a three-way Foley catheter, which is attached to the abdominal end of the No. 2 silk. The open end of the bag is then placed over the conduit and suction is applied to the end of the Foley catheter, causing the bag to collapse around the conduit. Under continuous suction, the Foley catheter with attached bag is then gently pulled in a cranial direction to deliver the conduit to the neck in an atraumatic fashion (Fig 2) [6].

Once the conduit is in the neck, either a hand-sewn technique with a single layer of No. 3/0 silk or a stapled anastomosis is used [6]. A nasogastric tube is placed. A Jackson-Pratt (Snyder Hemovac wound drainage device; Zimmer, Dover, OH) 10–mm, closed suction drain is passed posterior to the anastomosis.

Statistics

Three-year survival was determined by Kaplan-Meier analysis, and patient survival was compared with the log-rank test. We evaluated the association of pre- and postsurgical variables (age, gender, histology, neoadjuvant chemoradiation, and T and N status), with survival using univariable and mutivariable Cox proportional hazards models.

Results

Mortality and Morbidity

There were no intraoperative deaths. In-hospital mortality or 30-day mortality (whichever was longer) was 3.6% (9 of 250). Three patients had pneumonia and progressive respiratory failure. Two patients died due to massive pulmonary embolism; 1 died due to sepsis in the setting of empyema due to conduit leak; 1 died due to ischemic bowel and multisystem organ failure; 1 died due to

Table 2. Major Complications (n = 250)

Complication	Frequency (n)
Recurrent laryngeal nerve injury	14% (35)
Chylothorax	9% (22)
Leak	8% (19)
Pneumonia	5% (13)
Postsurgical bleeding	2% (5)
Tracheoesophageal fistula	1% (2)
Adult respiratory distress syndrome	1% (2)
Empyema	1% (2)
Pulmonary emboli	1% (2)
Sepsis	0.4% (1)
Mediastinitis	0.4% (1)

Table 3. Survival and Chemoradiation in Stages 0 (Complete Response), I, II, and III

Pathological Stage (n = 238)	Neoadjuvant Treatment (%)	Median Survival (Months)	3-Year Survival (%)	95% CI
Stage 0 (Complete pathological response) (n = 60)	100	50	56	41–68
Stage I (n = 32)	59	53	65	41–82
Stage IIA (n = 67)	84	26	41	27–54
Stage IIB (n = 30)	87	40	46	23–67
Stage III (n = 49)	71	13	16	5–32

CI = confidence interval.

aspiration and respiratory arrest; and 1 died due to cirrhosis in the setting of ischemic necrosis of the conduit.

Early postoperative complications occurred in 50% (124 of 250) of the patients. Major complications were seen in 33% (83 of 250) of the patients (Table 2).

Recurrent laryngeal nerve (RLN) injury occurred in 14% (35 of 250). The diagnosis was made by laryngoscopy done on all patients who had a poor cough, hoarse voice, or cough with oral intake. The injury rate was 17% [29] in the first 167 patients and 7% [6] in the last 83 patients, once a technical change (isolation of the proximal esophagus with Penrose drain, see Surgical Technique) was uniformly applied during thoracotomy ($p = 0.03$). Once diagnosed, all RLN injuries were treated aggressively in order to prevent aspiration. Twenty-one (21 of 35) patients were treated with simple Gelfoam injection and did not require any further interventions. Five (5 of 35) were treated with medialization thyroplasty, and the remaining 9 (9 of 35) were treated with a combination of techniques. Two (2 of 9) patients, one of whom had a proximal esophageal tumor, had bilateral RLN injury requiring a temporary tracheostomy. Nerve function recovered in the case of the patient with the proximal tumor. The second patient died in a rehabilitation center due to a presumed pulmonary embolism.

Chylothorax occurred in 9% (22 of 250) of the patients. Eighty-six percent (19 of 22) of these patients had surgical intervention. Surgical ligation was successful in 84% (16 of 19) of the surgically treated patients, but in 16% (3 of 19), the chyle leak continued. Two of these patients required 2 weeks of parenteral support until the leak stopped. In 1 patient, talc pleurodesis was successfully performed after 2 weeks.

Leak from the conduit or anastomosis was observed in 8% (19 of 250) of the patients. Anastomotic leak occurred in 5.6% (14 of 250), whereas conduit leak was diagnosed in 2% (5 of 250). Leak due to conduit necrosis was seen in 2 patients, and leak from conduit suture lines was seen in 3 patients. Fourteen out of 14 anastomotic leaks were treated with simple cervical drainage and healed without any further complications. Those patients with conduit necrosis or leak from the staple line, who had some form of diversion or exclusion using a t-tube, recovered uneventfully. In 2 patients who did not have adequate diversion due to refusal for further surgery, sepsis and death occurred.

Median length of hospital stay was 13 days (5–330). Average intensive care unit stay was 1 day (0–183). Outliers, such as the patient who was in the hospital for 330 days, usually had issues related to infection as a result of conduit necrosis or empyema. Long-term complications were anastomotic stricture and gastric outlet obstruction. Strictures were observed in 26% (65 of 250) of the patients. Thirty-five percent (23 of 65) required three or more dilatations, and 65% (42 of 65) needed one or two dilatations. Gastric outlet obstruction was noted in 3% (8 of 250).

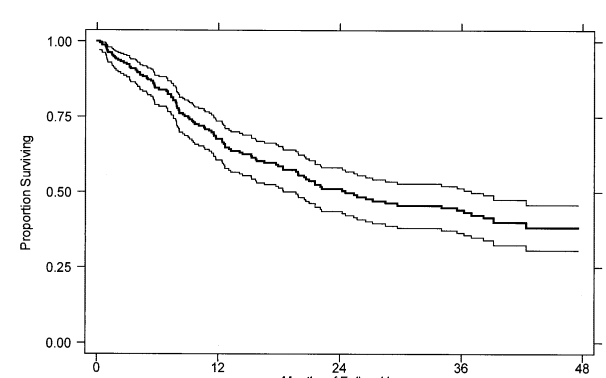
Response to Therapy and Survival

Complete resection was possible in 93% (232 of 250). Five percent (12 of 250) of the patients had microscopic tumor in proximal, distal, or deep margins. In 8 patients, the deep margin was positive; in 2, the proximal margin was positive; and in 2, both deep and proximal margins were positive. In 6 patients, tumor nodules were noted at the time of surgery in the liver [3], lung [1], a retroperitoneal lymph node [1], and in the subcutaneous tissue [1]. These 6 patients were unable to swallow after induction therapy and, therefore, needed palliation.

Thirty percent of the patients (60 of 202) who had neoadjuvant therapy for presumed T3 or 4 and/or N1 showed complete pathologic response with no viable tumor found in the surgical specimen. In this group of complete responders, 3-year survival was 56% (Table 3).

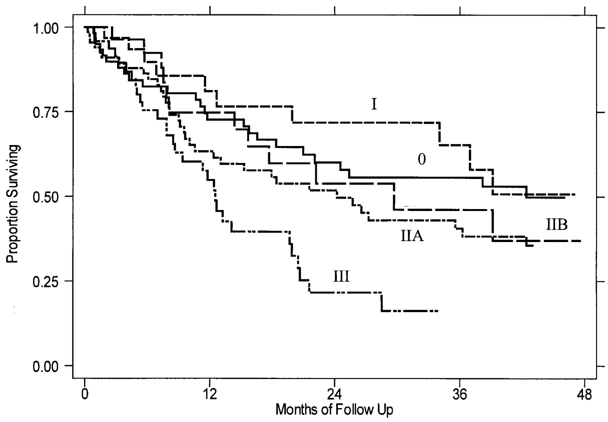
Overall 3-year survival was 44% (Fig 3, n = 238); median survival was 25 months. Mean follow-up was 24 months (SEM 1.6); median follow-up was 13.5 months (0.3 to 138 months).

Three-year survival by posttreatment stage (Fig 4, n = 238) was: stage 0 (complete response) (n = 60), 56%; stage I (n = 32), 65%; stage IIA (n = 67), 41%; stage IIB (n = 30),



Patients at risk	238	123	77	56	38

Fig 3. Overall survival after transthoracic esophagectomy with cervical esophagogastric anastomosis (n = 238). The upper and lower curves are the confidence intervals. Stage 0-tumor in situ (n = 5) and stage IV (n = 6) were excluded. One patient could not be staged.



Stage	Patients at risk				
0	60	38	28	22	14
1	32	19	14	10	7
2A	67	35	25	18	14
2B	30	16	9	7	4
3	49	19	5	3	3

*Fig 4. Survival by postsurgical pathologic stage (n = 238). Stage 0-tumor in situ (n = 5) and stage IV (n = 6) were excluded. One patient could not be staged. Survival at 3 years in patients with stage 0 (complete response) or stage I was significantly better when compared with patients with stage III (*p = 0.001, p = 0.002, *respectively).*

46%; and stage III (n = 49), 17% (Table 3). At 3 years, survival of patients with stage 0 (complete response) or stage I was significantly better when compared with that of patients with stage III ($p = 0.001$, $p = 0.002$, respectively). Other comparisons were not significant. Twelve patients (5 with tumor in situ, 6 with stage IV disease, and 1 patient who could not be staged according to the pathologic stage because the only tumor found was in the biopsy specimen) were excluded from survival and multivariate calculations.

Local recurrence occurred in 5.6% (14 of 250) of the patients. The site of recurrence was anastomotic in 6 (4 of 6 with positive resection margins), mediastinum in 4, celiac lymph node in 2, and on the left main bronchus in 2.

Univariate and Multivariate Analysis of Risk Factors

Risk factors that affect patient survival after esophagectomy were assessed with univariate and multivariate analyses (Table 4). In univariate analysis, older age (> 65), postsurgical T status (T3), and postsurgical N status (N1) were found to be significant risk factors ($p = 0.002$, $p = 0.004$, $p = 0.02$, respectively).

Multivariate analysis was performed in different models to demonstrate precisely the contribution of each factor. Because there was a considerable overlap between T and N status, they were evaluated separately with age in two different models. Older age (> 65) was significant in both models ($p = 0.001$, same p value in both analyses). N status when analyzed with age was also significant ($p = 0.02$). Pathologic T1, T2, and T3 were analyzed together with age. Only T3 together with age was a significant determinant of survival ($p = 0.003$).

Comment

Our technique for esophagectomy is intended to combine the advantages of a thoracic and transhiatal approach, as discussed below.

In this cohort of 250 patients, this technique was safe with no intraoperative deaths and an in-hospital mortality rate of 3.6%, even though 81% of the group (202 patients) received induction therapy. In part, the low mortality rate is attributable to the excellent nutritional status of our patients at the time of resection due to the use of jejunostomy enteral feeding during their induction therapy [10]. In most other contemporary series, the use of induction therapy is more limited, ranging between 0% and 29% of patients with reported mortality rates of 3% to 15% [11–16].

We perform a limited posterolateral thoracotomy to mobilize the tumor and all lymph nodes under direct visualization, thus making uncontrolled bleeding negligible and improving the ability to completely resect the tumor compared with the blunt transhiatal dissection. Radical intrathoracic dissection of the esophagus with all intrathoracic lymph nodes provides more precise staging information and may improve local control rates. Additionally, in the postinduction resection patient, information about the status of the lymph nodes is of critical importance in interpreting therapeutic response. Disadvantages of a thoracotomy include respiratory complications and postthoracotomy pain. A limited posterolateral incision and epidural analgesia for postoperative pain management have led to a low incidence of pulmonary complications in the series reported here.

The use of an intrathoracic anastomosis, as in an Ivor-Lewis approach, limits the proximal margin, and in the case of leak, has a significant associated morbidity [17, 18] and mortality, which ranges as high as 64% in some series [17–20]. In case of a leak from a cervical anastomosis, simple drainage of the neck wound at the bedside generally resolves the problem, as was the case in our series. Another advantage of a neck anastomosis is that it is situated out of the irradiated field. This was

Table 4. Univariate and Multivariate Analysis of Risk Factors With Cox Proportional Hazards Model

Risk Factors	Hazard Ratio (95% CI)	p Value
Univariate analysis		
Age (> 65 years)	1.7 (1.2–2.4)	0.002
Postoperative T status (T3 vs T0-2)	1.7 (1.2–2.4)	0.004
Postoperative N status (tumor-positive lymph nodes)	1.5 (1.1–2.2)	0.02
Multivariate analysis		
Age (> 65 years)	1.8 (1.2–2.6)	0.001
Postoperative T status (T3 vs T0-2)	2.5 (1.4–4.6)	0.003
Postoperative N status (tumor-positive lymph nodes)	1.6 (1.1–2.3)	0.02

CI = confidence intervals.

pertinent to our series because most of our patients received preoperative radiation. A significant incidence of bile reflux has been reported after an intrathoracic anastomosis, and in one report, 20% of cases required repeat surgery for resolution [21]. This was less common after a cervical anastomosis, with a 3% severe reflux rate reported in a recent series by Orringer [11]. A disadvantage of a neck anastomosis is a higher incidence of RLN injury (7% and 11.5%) [11, 22] compared with an intrathoracic technique (0% and 1.3%) [23, 24]. We have made a technical adjustment to address RLN injury. Because a longer conduit is necessary, ischemia to the conduit is a potential problem. This occurred rarely in our series.

The incidence of complications after esophagectomy is high due to the technical and anatomic challenges of the procedure. However, the overall incidence of complications in our series is similar to reports using the other surgical techniques. The RLN injury rate in the last 83 patients (7%) in our series (patients who underwent surgery with the adjusted technique) is comparable with other series [11–15, 22, 25]. Reported anastomotic leak rates are between 0% and 20% after esophagectomy [11–14, 16–20, 25], and in our series, we observed 14 (5.6%) true anastomotic leaks. The chylothorax incidence in our series was high, possibly due to the fragility of mediastinal tissues after neoadjuvant treatment and radical lymph node dissection. Despite prophylactic suturing of the duct, some patients developed leaks. In these patients at the time of reexploration, the leak often occurred from a plexus of lymphatic channels associated with the subcarinal nodal basin.

A more extensive lymph node dissection is favored by some centers. Altorki and colleagues reported a 34.5% 4-year survival rate for the patients who underwent en bloc esophagectomy with three-field (abdominal, mediastinal, and cervical) lymph node dissection [12]. In our series, 3-year survival is 44%. For comparison purposes, although the number of patients at risk is limited, our 4-year survival is 38%.

With respect to the success of transhiatal esophagectomy, Orringer's series of 800 patients with esophageal carcinoma reported a 5-year survival rate of 23% [11]. Orringer reported a mortality rate of 4% and an anastomotic leak rate of 13%. Atelectasis and pneumonia were observed in a low percentage of patients (2%), as in our series.

Many centers have reported results using a right-sided intrathoracic anastomosis (Ivor-Lewis type) [13–15, 23–26]. In experienced hands, this technique is safe. For tumors in the midesophagus, it may not be as applicable a technique as using a cervical anastomosis, given the constraints on the surgical margin.

Other variations of the technique described in this paper have been reported by McKeown, who first described the three-incisional approach, and a group from Vancouver [27, 28]. Nanson also reported a similar technique in 4 patients [29]. They are small series with higher morbidity and mortality than our report, perhaps representing an earlier era.

Eighty-one percent (202 of 250) of our cohort received induction therapy, and this may account for our high complete resection rate. In those patients who had a complete response to induction therapy (30%), a reasonable long-term survival is seen, particularly in light of their advanced locoregional disease before therapy.

Total thoracic esophagectomy with cervical esophagogastrostomy, radical lymph node dissection, and jejunostomy feeding tube placement appears to be a safe surgical option particularly in the setting of induction therapy, and offers reasonable long-term survival. Those patients whose tumors demonstrate a complete response after induction therapy appear to have improved survival.

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References

1. Blot WJ, Fraumeni JF Jr. Trends in esophageal cancer mortality among U.S. blacks and whites. Am J Public Health 1987;77:296–8.
2. Greenlee RT, Hill-Harmon MB, Murray T, Thun M. Cancer statistics, 2001. CA Cancer J Clin 2001;51:15–36.
3. Lund O, Hasenkam JM, Aagaaed MT, et al. Time-related changes in characteristics of prognostic significance in carcinomas of the esophagus, and cardia. Br J Surg 1989;76: 1301–7.
4. Lewis I. The surgical treatment of carcinoma of the esophagus: special reference to a new operation for growth of the middle third. Br J Surg 1946;33:19–31.
5. Turner GC. Carcinoma of the esophagus: the question of its treatment by surgery. Lancet 1936;1:130–4.
6. Swanson SJ, Sugarbaker DJ. The three-hole esophagectomy: The Brigham and Women's Hospital approach (Modified McKeown technique). Chest Surg Clin North Am 2000;10: 531–52.
7. Sugarbaker DJ, DeCamp MM, Liptay MJ. Procedures to resect and replace the esophagus. In: Zinner MJ, Schwartz SI, Ellis H, eds. Maingot's abdominal operations, 12th ed. Stamford, CT: Appleton & Lange, 1997:885–905.
8. McKeown K. Total three-stage oesophagectomy for the cancer of the oesophagus. Br J Surg 1976;63:259–63.
9. Union Internationale Contre le Cancer. In: Hermanek P, Sobin LH, eds. TNM classification of malignant tumors, 4th ed. Berlin: Springer-Verlag, 1987:80–9.
10. Swanson SJ, Grondin SC, MacBurney MM, et al. Supportive enteral feeding during induction therapy (IT) for esophageal carcinoma [Abstract]. Prog Proc Am Soc Clin Oncol 1999;18: 301.
11. Orringer MB, Marshall B, Iannettoni MD. Transhiatal esophagectomy: clinical experience and refinements. Ann Surg 1999;230:392–403.
12. Altorki NK, Girardi L, Skinner DB. En bloc esophagectomy improves survival for Stage III esophageal cancer. J Thorac Cardiovasc Surg 1997;114:948–56.
13. Pac M, Basoglu A, Kocak H, et al. Transhiatal versus transthoracic esophagectomy for esophageal cancer. J Thorac Cardiovasc Surg 1993;106:205–9.
14. Nishihira T, Hirayama K, Mori S. A prospective randomized trial of extended cervical and superior mediastinal lymphadenectomy for carcinoma of the thoracic esophagus. Am J Surg 1998;175:47–51.
15. Akiyama H, Tsurumaru M, Watanabe G, Ono Y, Udagawa H, Suzuki M. Development of surgery for carcinoma of the esophagus. Am J Surg 1984;147:9–16.
16. Chu KM, Law SYK, Fok M, Wong J. A prospective randomized comparison of transhiatal and transthoracic resection for lower-third esophageal carcinoma. Am J Surg 1997;174: 320–4.

17. Urschel JD. Esophagogastrostomy anastomotic leaks complicating esophagectomy: a review. Am J Surg 1995;169:634–40.
18. Muller JM, Erasmi H, Stelzner M, Zieren U, Pichmaier H. Surgical therapy of esophageal carcinoma. Br J Surg 1990;77: 845–57.
19. Patil PK, Patel SG, Mistry RC, Deshpande RK, Desai PB. Cancer of the esophagus: esophagogastric anastomotic leak: a prospective study of predisposing factors. J Surg Oncol 1992;49:163–7.
20. Agrawal S, Deshmukh SP, Patil PK, et al. Intrathoracic anastomosis after oesophageal resection for cancer. J Surg Oncol 1996;63:52–6.
21. Baba M, Aikou T, Natsugoe S, et al. Appraisal of ten-year survival following esophagectomy for carcinoma of the esophagus with emphasis on quality of life. World J Surg 1997;21:282–5.
22. Vigneswaran WT, Trastek VF, Pairolero PC, Deschamps C, Daly RC, Allen MS. Transhiatal esophagectomy for carcinoma of the esophagus. Ann Thorac Surg 1993;56:838–46.
23. Mathisen DJ, Grillo H, Wilkins EW, Moncure AC, Hilgenberg AD. Transthoracic esophagectomy: a safe approach to carcinoma of the esophagus. Ann Thorac Surg 1988;45: 137–43.
24. Ellis FH, Heatley GJ, Krasna MJ, Williamson WA, Balogh K. Esophagogastrectomy for carcinoma of the esophagus and cardia: a comparison of findings and results after standard resection in three consecutive eight year intervals with improved staging criteria. J Thorac Cardiovasc Surg 1997; 113:836–48.
25. Stark SP, Romberg MS, Pierce GE, et al. Transhiatal versus transthoracic esophagectomy for adenocarcinoma of the distal esophagus and cardia. Am J Surg 1996;172:478–92.
26. Turnball ADM, Ginsberg RJ. Options in the surgical treatment of esophageal carcinoma. Chest Surg Clin North Am 1994;4:315–29.
27. McKeown KC. The surgical treatment of carcinoma of the oesophagus: a review of the results in 478 cases. J R Coll Surg Edinburgh 1985;30:1–14.
28. Finley RJ, Lamy A, Clifton J, Evans KG, Fradet G, Nelems B. Gastrointestinal function following esophagectomy for malignancy. Am J Surg 1995;169:471–5.
29. Nanson EM. Synchronous combined abdomino-thoraco-cervical esophagectomy. Aust NZ J Surg 1975;45:340–8.

DISCUSSION

DR KEITH S. NAUNHEIM (St. Louis, MO): I would like to thank the Society for allowing me to discuss this paper, and also Dr Swanson and his colleagues for providing me with a copy of the manuscript in advance of the meeting.

Over the past two decades, there has been a great deal of controversy regarding the optimal approach to esophageal resection. Many surgeons have opted to utilize a transhiatal approach, suggesting it is less invasive and results in less operative morbidity than a transthoracic approach. The overall results of Dr Swanson and his colleagues presented here today utilizing just such a transthoracic approach are generally very good. This paper confirms my personal belief that the eventual clinical outcome hinges more on the skill and experience of the operative team than it does on the site or the number of incisions. Controversies regarding differences in postoperative morbidity and length of stay will undoubtedly continue, and it is unlikely that a prospective randomized trial, unless of a significantly large size, will ever answer these questions.

I do have four issues that I would like Dr Swanson to address. First, you report performing 250 consecutive total esophagectomies over 11 years, during which time you operated on a total of 342 patients. What were those procedures in the remaining 92 patients? In any oncologic report, it is critical to understand how patients are selected for surgical intervention. How many esophageal cancer patients were seen that were not operated on, what were the exclusion criteria, and do you think this had anything to do with an upward or downward shift in your morbidity and long-term survival?

Second, with regard to long-term survival, your actuarial curves do not appear to fit what most of us would expect, that is, a stepwise decline in survival as stage increases. Your survival curves for stages 0, 1, 2A, and 2B range from 33% to 42% 5-year survival and seemed to show little difference between groups in which we would expect to find some survival discrimination. Do you think this is the result of including a variety of preoperative treatment regimens ranging from no treatment to aggressive pre- and postoperative multimodality therapy, or is there another explanation?

My third question deals with the 5% incidence of postoperative pneumonia noted in your paper, a figure that is surprisingly low when compared with other series. This is even more unusual in that it occurred in the face of what was, at least early in the experience, a relatively high rate of recurrent laryngeal nerve injury. Could you explain why this incidence of pneumonia was so low? What were your clinical findings required to diagnose pneumonia, and did you utilize any special maneuvers to avoid pneumonia, such as minitracheostomy or early vocal cord visualization with cessation of oral intake when paralysis was identified?

Lastly, your manuscript cites a local recurrence rate of only 5.6%, once again, a figure that is remarkably low. Could you explain how you believe this was achieved, and perhaps you could give us some idea of the breakdown for the sites of tumor recurrence at distant sites.

I would like to thank the Society for the privilege of discussing this manuscript.

DR JOE B. PUTNAM (Houston, TX): Dr Swanson, I appreciated your comments and just have two questions to complement Dr Naunheim's words. I would like clarification on your description of your radical lymph node dissection. At our institution, with our neo-adjuvant treatment of esophageal carcinoma, we are customarily using either a two-field, chest and abdomen, or a three-field, neck, chest, and abdomen, approach as our operations of choice. Within the three-field esophagectomy, we will dissect at least four stations in the chest to remove all nodal tissue within the mediastinum. In the abdomen, particular attention is directed to lymph node dissection around the gastroesophageal junction, the left gastric artery, and the celiac artery. Your stapler across the left gastric vascular bundle may preclude such a dissection in the abdomen. Second, was the extent of your lymph node dissection a D0, D1, or D2 extent?

I certainly appreciated your comments.

DR JAMES D. LUKETICH (Pittsburgh, PA): Again, I appreciated the presentation; very nice data. You are dealing primarily with EG junction tumors today, and several minimally invasive studies have shown the incidence of small undetected mets in the abdomen, like a small liver met or a pleural surface or gastric extension, can occur anywhere, from as low as 12% to 38%, depending on which study you read, and you are advocating starting in the right chest. Are you going to modify that for GE junction tumors, or have you? Are you thinking about doing a quick initial laparoscopy on the table? And what would you do if you have completely mobilized the esophagus in the right chest and then you go to the abdomen and you find a small liver met or a problem, what is your approach? Thank you.

DR SWANSON: Thank you very much for all the very good questions and the kind comments of Dr Naunheim. The four questions that he asked I will take one at a time, in order.

Of the 342, 250 were the three-incisional approach and 92 were transhiatal or left thoracoabdominal. The majority of these were transhiatal and generally for very early stage tumors. Our philosophy had been that anybody with beyond a T2 or any nodal involvement got induction therapy. For people with T1 tumors, some of the surgeons preferred a transhiatal approach.

As to why the three graphs of stages tended to overlap, I think it has to do with the fact that 80% of the patients got induction therapy, and here we presented posttreatment stages. The overall group was not as pure as you have seen in other studies where the induction rate is 20% or 30%.

In terms of the pneumonia rate of 5%, all patients got an epidural catheter and everybody was out of bed the first day. I think that is one of the major reasons for that low number. We rarely use minitracheostomies. I think 1 patient in the series had one.

In terms of the recurrent nerve injury and why we did not see more pneumonias, the injuries are not detected by swallow. They are usually picked up in the first or second day if there is any question about the integrity of the cough or voice. We bronchoscope the patient and look at the cords on day 1, and if there is any question, we have our ENT colleagues come in and do an injection either on day 1 or 2 to try to avoid respiratory issues. It has been effective to be proactive in that way.

The 5% local recurrence rate we feel is low and probably due to the 80% induction therapy rate. Some of it may have to do with the fact that we were able to perform a careful dissection using a thoracotomy. The recurrences locally were at the main stem bronchus, the anastomosis in four, celiac node bed, and mediastinum. In terms of distant metastases, I do not have that data.

In terms of Dr Putnam's question about lymph node dissection, we sweep all the tissue at the celiac axis up onto the specimen before dividing the vascular pedicle. I do not think a stapler makes any difference relative to a clamp, and if there are any other nodes in that area, we remove them after dividing the pedicle. Our dissection is not a three-field dissection. It is a perigastric, periceliac, and intrathoracic dissection.

Regarding Dr Luketich's question, certainly it was something we all wondered and thought carefully about, but it turns out only 2 patients have had their thoracic esophagus mobilized and then found to be unresectable and therefore closed. They both did fine, probably because of the extensive intramucosal plexus of vasculature in the esophagus. Two patients at laparotomy were found to have liver metastases, and for symptomatic reasons (both patients had significant dysphagia after induction therapy) went on to have a resection in the setting of liver metastases.

Thank you very much.