ORIGINAL ARTICLE

# A Single-Layer, Continuous, Hand-Sewn Method for Esophageal Anastomosis

## *Prospective Evaluation in 218 Patients*

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**Hypothesis:** A 1-layer, continuous technique for esophageal anastomosis after esophagectomy has been in routine use at the University of Hong Kong Medical Centre since 1996. This study aims to document the results of this method and examine factors that may predispose patients to complications associated with esophageal anastomosis.

**Design:** Retrospective study.

**Setting:** University academic surgical center.

**Patients and Methods:** We studied 218 consecutive patients who had an esophageal anastomosis constructed with a 1-layer, continuous technique. Data were prospectively collected.

**Main Outcome Measures:** Morbidity and mortality rates, anastomotic leaks, stricture, and recurrences.

**Results:** Anastomotic leaks affected 7 patients (3.2%), of whom 3 required surgical reexploration and none died. The hospital mortality rate was 0.9% (2 patients), attributed to myocardial infarction and malignancy. Anastomotic strictures developed in 24 patients (11.1%). Multivariate analysis in those with gastric conduits showed that a cervical anastomosis (intrathoracic vs cervical; odds ratio, 0.27; 95% confidence interval, 0.08-0.87; $P=.03$) and use of the distal stomach (distal stomach vs whole stomach; odds ratio, 5.25; 95% confidence interval, 1.65-16.66; $P=.005$) were predictive of benign anastomotic stricture formation. Eleven patients (17.5%) who had a cervical anastomosis developed strictures compared with 13 (8.6%) in those who had intrathoracic anastomoses. Strictures developed in 12 patients (7.4%) with a whole stomach conduit and in 9 patients (19.6%) with a distal stomach conduit. Anastomotic recurrence occurred in 8 patients (3.7%); none had a histologically involved resection margin.

**Conclusions:** The single-layer, continuous, hand-sewn technique for esophageal anastomosis is safe and effective. Cervical anastomosis and use of the distal stomach were associated with more benign strictures.

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Many advances have been made in the treatment of cancer of the esophagus in the past decade. In specialized centers, mortality rates are low[1-4]; however, complications after esophagectomy are still frequent. Anastomotic leak between the esophagus and the conduit used for esophageal replacement is the most common complication among surgical anastomoses. It remains a principal cause of surgical sepsis, and its associated morbidity and mortality are high. The incidence of this complication varies widely. In some studies, leak rates of up to 30% are reported.[5] Other anastomotic problems that are encountered include anastomotic stricture and recurrence. Both defeat one of the main aims of surgical resection, which is the relief of dysphagia.

Surgical technique for esophagectomy and reconstruction may influence the occurrence of such anastomotic problems. Controversies exist regarding the optimal method to minimize these risks. In a randomized trial performed at the University of Hong Kong Medical Centre that compared stapled and hand-sewn intrathoracic anastomosis, leak rates were similar for both groups (4.9% for the stapled method vs 1.6% for the hand-sewn method), but the stricture rate was substantially higher for the stapled group (40.0% vs 9.1%).[6] Because of the results of this study, since 1996, all esophageal anastomoses at the University of Hong Kong Medical Centre have been hand sewn using a 1-layer, continuous technique with a monofilament absorbable suture (Maxon, 4-0 polyglyconate; Davis and Geck, Danbury, Conn), regardless of the site of anas-

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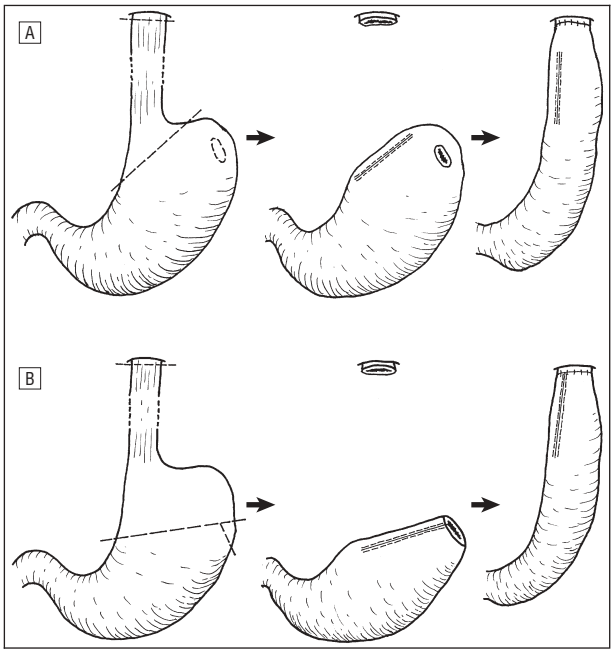


**Figure 1.** Design of 2 types of gastric conduit. A, Line of transection (dotted line) of the stomach with linear stapler when the whole stomach was used. The anastomosis was constructed after a disk of fundus was removed. B, Line of transection (dotted line) of the stomach with linear stapler when the distal stomach was used. A cuff of stomach at the stapled line was cut away; the anastomosis incorporated the stapled line.

tomosis.[7] The aims of the present study were (1) to document the surgical results of the routine use of the 1-layer, continuous, hand-sewn technique in esophageal anastomosis and (2) to identify possible predisposing factors for development of leakage and stricture using this uniform method.

## METHODS

Between January 1996 and December 2002, 647 patients with carcinoma of the esophagus and gastric cardia were treated in the Department of Surgery, University of Hong Kong Medical Centre, at Queen Mary Hospital. Patients with gastric cardia cancers and cervical esophageal cancers were excluded from this study because of different oncologic characteristics and treatment protocols. Only patients with intrathoracic squamous cell cancers were included. We studied 218 patients who satisfied the inclusion criteria and underwent resection. All data were collected in a prospective database. Supplementary information was obtained from medical record review.

The surgical techniques have previously been described.[7,8] In brief, a Lewis-Tanner esophagectomy[7] via an abdominal, right-sided thoracotomy approach was most commonly used. For patients who had a tumor of the superior mediastinal segment, a 3-phase esophagectomy was performed. Transhiatal esophagectomy was selectively applied for tumors of the lower third of the esophagus.[9] Thoracoscopic esophageal mobilization has been used since the latter part of 1994[10,11] and has largely replaced the need for transhiatal esophagectomy. This procedure was selected only for high-risk patients.

Lymphadenectomy usually involved a 2-field lymphadenectomy with dissection of lymph nodes around the celiac trifurcation and also an infracarinal mediastinal lymph node dissection. Lymph nodes of the superior mediastinum were sampled or resected when found. In patients who underwent transhiatal resection, no formal mediastinal lymphadenectomy was performed and only accessible lymph nodes were sampled. Cervical lymphadenectomy was not performed routinely because our study of recurrence patterns suggested a limited value to neck dissection[12] and the survival advantage of cervical lymphadenectomy was not proved.[13]

Reconstruction of intestinal continuity was usually restored with a gastric conduit placed in the right side of the thoracic cavity (after Lewis-Tanner esophagectomy) or via the orthotopic route when the anastomosis was performed in the neck. In the obviously palliative cases in which residual mediastinal disease was evident, the retrosternal route was chosen in a 3-phase esophagectomy.

The stomach was the preferred organ used as the esophageal substitute. It was divided by linear staplers. In most patients, the whole stomach was used for reconstruction, with the line of gastric transection extending from a point chosen at the low lesser curvature to the gastric fundus.[14] The distal part of the stomach was used for reconstruction when the proximal part of the stomach had been resected with the esophagus. This was indicated either because the gastric fundus was redundant (regardless of location of the primary tumor) or when the esophageal tumor was close to the esophagogastric junction. When the whole stomach was used, a disk of the stomach wall was removed (gauged at the size of the divided esophageal stump) at the tip of the fundus, and the anastomosis was constructed at this site. When the distal stomach was used, the tip of the gastric tube with the uppermost part of the linear stapled line was removed, and thus the stapled line was incorporated into the esophagogastric anastomosis (**Figure 1**A and B). Pyloroplasty was routinely added for all gastric conduits.[15,16]

The jejunum or colon was selected in patients who had undergone a previous gastrectomy. In general, the right colon with the terminal ileum was preferred; all colonic anastomoses were made in the neck, with the terminal ileum joining the cervical esophagus.[17] The jejunum was rarely used, except for low intrathoracic cancers for which an intrathoracic anastomosis was planned.

All anastomoses were constructed with a 1-layer, continuous technique with an absorbable monofilament suture (Maxon, 4-0 polyglyconate) (**Figure 2**A-D).[7] This method of anastomosis required 2 single-armed sutures securely tied at the ends. The posterior layer of the anastomosis took full thickness of both the esophagus and conduit, whereas the anterior layer was completed by taking only the seromuscular wall of the substitute but a full thickness of the esophagus with minimal mucosa. Each bite of the sutures was evenly placed (approximately 5 mm apart at a 5-mm depth) without pulling the sutures too tight to avoid strangulation of tissue.

Patients were given neoadjuvant treatment only in the context of clinical trials.[18] Preoperative chemoradiation therapy was studied in a randomized trial for resectable tumors compared with resection alone. Patients with locally advanced tumor (stage T4) or nonregional nodal spread (eg, cervical lymph nodes) were palliated with up-front chemoradiation. Surgical resection was offered for those with significant downstaging. Adjuvant radiotherapy was selectively given postoperatively for patients with gross residual tumor (R2 resection) or microscopic disease at the resection margins (R1 resection).[19]

Patients usually began taking fluids orally by the fourth day after surgery. All patients underwent a contrast swallow study on the seventh day, and if normal, diet was advanced as tolerated. Endoscopic examination before discharge was routine in the past, but in recent years it has been performed only selectively because the incidence of leak and abnormality is low. A diagnosis of anastomotic leak was made using the contrast swallow study and on clinical grounds.



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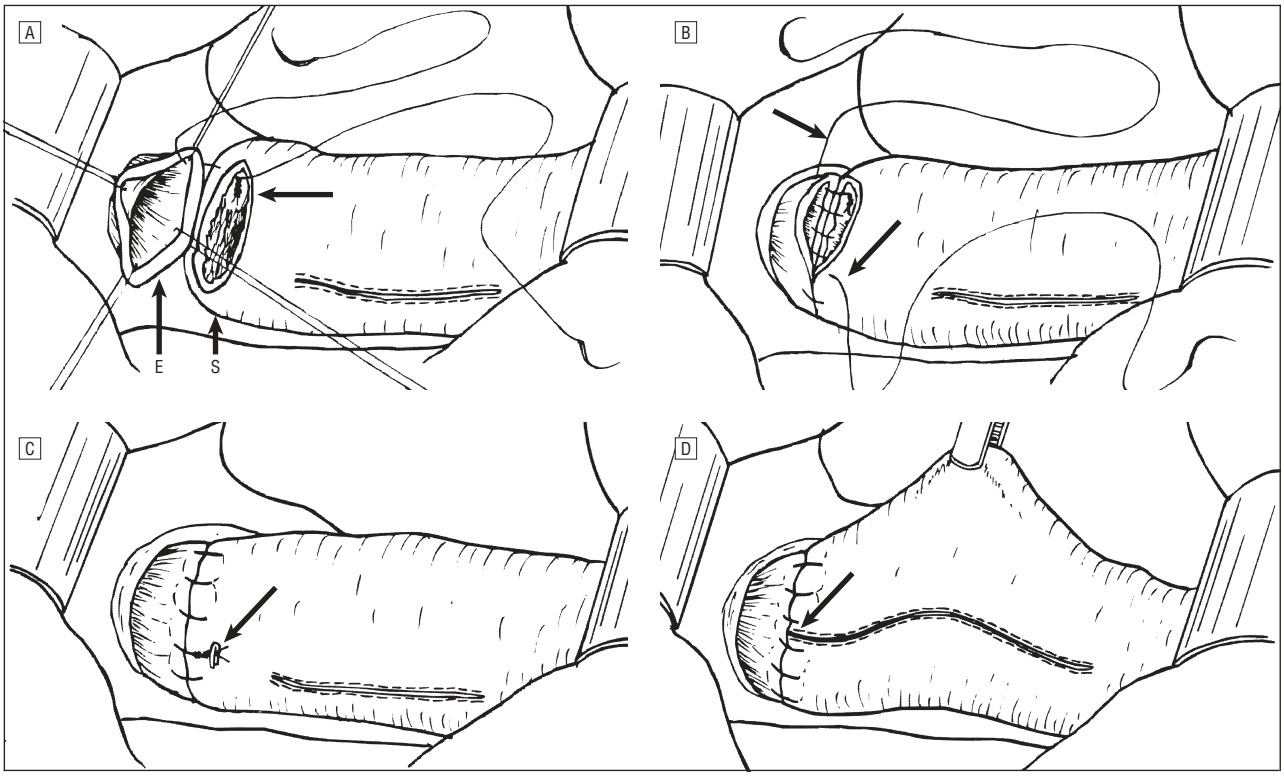


**Figure 2.** Technique of the single-layer, hand-sewn anastomosis. A, Technique of hand-sewn anastomosis showing the 2 single-armed sutures tied at the ends. One stitch is first passed from the stomach (S) to the esophagus (E), and the posterior wall is sutured with full-thickness bites. Horizontal arrow shows the knot anchored inside the lumen. B, The posterior wall is completed; the first stitch is now brought out from the stomach side (upper arrow). The anterior wall is begun, and the second stitch is brought out through the esophageal lumen (lower arrow). C, The anastomosis is completed with the 2 stitches tied. A clip is placed on the stitch to mark the site of anastomosis (arrow). D, The anastomosis is completed when the distal stomach is used, with the stapled line (arrow) incorporated into the anastomosis.

Major pulmonary complications included bronchopneumonia, aspiration pneumonia, and respiratory failure (diagnosed with blood gas criteria with or without ventilatory support). Major cardiac morbidities included myocardial infarction and heart failure. Arrhythmias commonly included atrial fibrillation, although this was mostly benign in nature, and were reflective of underlying sepsis and respiratory status.[20] Surgical complications included anastomotic leak, recurrent laryngeal nerve palsy, chylothorax, gangrene of the conduit, gastric outlet obstruction, wound infection, and complications that required surgical reexploration. Death within 30 days of surgery was recorded as 30-day mortality, whereas hospital mortality was defined as any death in the hospital after surgery.

The resected specimens were collected and dissected while fresh. Pathologic staging was performed according to the tumor-node-metastasis (TNM) criteria.[21] The proximal resection margin was recorded as the distance from the proximal tumor margin to the transection line in the fresh contracted specimen.

After discharge from the hospital, regular follow-up visits were arranged. Endoscopy was performed when symptoms of dysphagia recurred. An anastomotic stricture was defined as a stenosis through which a flexible endoscope (Olympus XQ-240, 9-mm diameter; Olympus Corp, Tokyo, Japan) could not pass and that required endoscopic dilation. Anastomotic recurrence was defined using endoscopy with histologic confirmation. In calculating the incidence of anastomotic stricture, hospital deaths and patients who had gangrene of the conduit as well as staged reconstructions were excluded because the original conduit was resected. Similarly, in the calculations of anastomotic recurrence rates, these patients were also excluded because further resection of the esophageal stump was performed during the staged reconstructive procedure, which would make the interpretation of data on histologic involvement of the resection margin difficult.

Continuous data are presented as mean (SD). Comparisons between groups were made by the 2-tailed *t* test, Mann-Whitney *U* test, $\chi^2$ test, and Fisher exact test where appropriate. Logistic regression analysis was used to identify factors predictive of anastomotic stricture. $P<.05$ was considered statistically significant. All statistical analyses were performed using the SPSS statistical package, version 8.0 (SPSS Inc, Chicago, Ill).

## RESULTS

Patient demographics and pathologic stage distributions of the 218 patients are given in **Table 1** and **Table 2**. One hundred thirty-four patients (61.5%) underwent surgical resection alone without prior neoadjuvant therapy. The location of the primary tumor, the route of reconstruction, the organ used for esophageal substitution, and the site of anastomosis are interdependent, and their relations with respect to the site of anastomosis are given in **Table 3**. Most patients with upper third tumors had cervical anastomoses, and when the stomach was used, the anastomoses to the distal stomach were mainly intrathoracic in location. The stomach was the organ most frequently used in 209 patients (95.9%); all 8 patients who had colonic interposition had the anastomoses constructed in the neck. For those who had cervical anastomosis, the orthotopic route was used in 49



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**Table 1. Patient Demographics in 218 Patients Who Underwent Resection**

| Demographics | No. (%) of Patients* |
|---|---|
| Age, mean ± SD, y | 64.3 ± 10.4 |
| Sex | |
| Male | 178 (81.7) |
| Female | 40 (18.3) |
| Level of tumor | |
| Upper | 33 (15.1) |
| Middle | 124 (56.9) |
| Lower | 61 (28.0) |
| Treatment | |
| Resection only | 134 (61.5) |
| Preoperative chemoradiation | 83 (38.1) |
| Preoperative radiotherapy | 1 (0.5) |
| Postoperative radiotherapy | 11 (5.0) |

*Data are presented as number (percentage) of patients unless otherwise indicated.

**Table 2. Pathologic Stage Distributions and R Category of Resection in 218 Patients**

| Variable | No. (%) of Patients |
|---|---|
| T stage | |
| T0 | 35 (16.1) |
| T1 | 22 (10.1) |
| T2 | 32 (14.7) |
| T3 | 97 (44.5) |
| T4 | 32 (14.7) |
| N stage | |
| N0 | 122 (56.0) |
| N1 | 96 (44.0) |
| M stage | |
| M0 | 197 (90.4) |
| M1 | 21 (9.6) |
| TNM stage | |
| Tis | 2 (0.9) |
| I | 16 (7.3) |
| IIa | 61 (28.0) |
| IIb | 10 (4.6) |
| III | 75 (34.4) |
| IV | 21 (9.6) |
| 0* | 23 (10.6) |
| T0 N1† | 10 (4.6) |
| R category | |
| R0 | 171 (78.4) |
| R1/R2 | 47 (21.6) |

*Pathologic complete response induced by preoperative therapy.
†Tumors after preoperative therapy resulted in sterilization of the primary tumor but persistent lymph node disease.

**Table 3. Level of Tumor, Organ Used as Esophageal Substitute, and Route of Reconstruction With Respect to Site of Anastomosis***

| Variable | Cervical Anastomosis (n = 64) | Intrathoracic Anastomosis (n = 154) | *P* Value |
|---|---|---|---|
| Level of tumor | | | <.001 |
| Upper | 31 (48.4) | 2 (1.3) | |
| Middle | 25 (39.1) | 99 (64.3) | |
| Lower | 8 (12.5) | 53 (34.4) | |
| Conduit used | | | <.001 |
| Whole stomach | 55 (85.9) | 108 (70.1) | |
| Distal stomach | 1 (1.6) | 45 (29.2) | |
| Colon | 8 (12.5) | 0 | |
| Jejunum | 0 | 1 (0.6) | |
| Route of reconstruction | | | |
| Intrathoracic | 0 | 154 (100) | |
| Orthotopic | 49 (76.6) | 0 | |
| Retrosternal | 15 (23.4) | 0 | |

*Data are presented as number (percentage) of patients.

**Table 4. Postoperative Complications and Mortality After Esophagectomy**

| Variable | No. (%) of Patients |
|---|---|
| Major pulmonary | 41 (18.8) |
| Major cardiac | 4 (1.8) |
| Arrhythmia | 45 (20.6) |
| Renal failure | 1 (0.6) |
| Anastomotic leak | 7 (3.2) |
| Other leaks | 1 (0.5) |
| Recurrent laryngeal nerve palsy | 29 (13.3)* |
| Chylothorax | 9 (4.1) |
| Gangrene of conduit | 2 (0.9) |
| Gastric outlet obstruction | 4 (1.8) |
| Wound infection | 6 (2.8) |
| Reexploration | 14 (6.4) |
| Chylothorax | 5 (2.3) |
| Anastomotic leak | 2 (0.9) |
| Gangrene of conduit | 2 (0.9) |
| Bleeding | 1 (0.46) |
| Jejunostomy tube leak | 1 (0.46) |
| Hiatal herniation of bowel | 1 (0.46) |
| Severe wound infection | 1 (0.46) |
| Broken chest drain | 1 (0.46) |
| 30-Day mortality | 0 |
| Hospital mortality | 2 (0.9) |

*Fifteen patients (52.0%) were transient.

patients (76.6%) and the retrosternal route in 15 (23.4%).

Postoperative complications are given in **Table 4**. Pulmonary complications and arrhythmias were the most common. Seven patients (3.2%) developed anastomotic leaks, 2 of whom had a cervical anastomosis and 5 of whom had an intrathoracic anastomosis ($P>.99$). Both patients with cervical leaks required exploration of the neck with drainage. In those who had intrathoracic leaks, 1 patient required thoracotomy and lung decortication with drainage. The remaining 4 were all treated nonoperatively with chest tube drainage. No patient died as a result of anastomotic leaks. The different conduits used had leak rates of 3.2% (5/158) for the whole stomach, 2.2% (1/45) for the distal stomach, 0% for the jejunum, and 12.5% (1/8) for the colon loop.

Two patients died. The first patient died of a myocardial infarction after apparent recovery from the esophagectomy; the second patient had undergone a resection for an advanced cancer of the tongue 9 months previously. After his esophagectomy, tumor recurrences developed within a short time. It was difficult to distinguish tumor recurrence from the tongue or esoph-



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**Table 5. Relation Between Upper Margin Involvement With Anastomotic Recurrence and Postoperative Radiotherapy**

| Upper Margin Involvement | Anastomotic Recurrence in Patients Undergoing Postoperative Therapy | | | Anastomotic Recurrence in Patients Not Undergoing Postoperative Therapy | | |
|---|---|---|---|---|---|---|
| | No | Yes | Total | No | Yes | Total |
| No | 193 | 8 | **201** | 9 | 0 | **9** |
| Yes | 3 | 0 | **3** | 2 | 0 | **2** |
| **Total** | **196** | **8** | **204** | **11** | **0** | **11** |

ageal cancer. He finally died of metastases 2 months after he underwent esophagectomy.

Twenty-four patients (11.1%) developed anastomotic stricture at follow-up. Logistic regression analysis tested the following variables as predictive factors for benign stricture formation: age, sex, site of anastomosis, route of reconstruction, conduit used, proximal resection margin length, previous anastomotic leak, preoperative neoadjuvant therapy, postoperative radiotherapy, R category of tumor, and the TNM stage of disease. Because the number of patients with jejunum (1) and colon conduits (8) were small, only stomach conduits (whole stomach and distal stomach) were included in the multivariate analysis. The site of the anastomosis (intrathoracic vs cervical; odds ratio, 0.27; 95% confidence interval, 0.08-0.87; $P=.03$) and the conduit used (distal stomach vs whole stomach; odds ratio, 5.25; 95% confidence interval, 1.65-16.66; $P=.005$) were independent factors predictive of stricture formation. Eleven patients (17.5%) who had a neck anastomosis developed strictures compared with 13 (8.6%) who had intrathoracic anastomoses. Strictures developed in 12 (7.4%), 9 (19.6%), 0, and 3 patients (37.5%) for the whole stomach, distal stomach, jejunal, and colon groups, respectively.

The esophagus at the resection margin was histologically involved in 5 patients (2.3%). The relationships of resection margin involvement, postoperative radiotherapy, and subsequent anastomotic recurrence are given in **Table 5**. Anastomotic recurrence occurred in 8 patients (3.7%); all had resection margins that were negative for tumor involvement and did not receive postoperative radiotherapy. None of the 5 patients who had a resection margin that was positive for tumor involvement, including 2 who underwent postoperative radiotherapy, developed anastomotic recurrence. The median follow-up time of these 5 patients was 11.6 months (range, 3.1-43.2 months). Four of these patients died of tumor-related causes; 1 patient is alive at 20 months after surgery, without evidence of disease. In all 8 patients who developed anastomotic recurrences, the proximal resection margin measured in the fresh contracted specimen was less than 5 cm. Overall median survival for all patients was 28.2 months. Survival after R0 resections was 33.7 months. Survival after R1/2 resections was 11.2 months ($P<.001$).

## COMMENT

A prospective randomized controlled trial was conducted at the University of Hong Kong Medical Centre comparing the hand-sewn and stapled techniques for intrathoracic esophagogastric anastomosis.[6] Both methods had low leak rates, but the hand-sewn technique was superior to the stapled method with respect to stricture formation and cost. Since then, all esophageal anastomoses have been hand sewn, regardless of the site of anastomosis and the conduits used. Our previous analyses[22,23] have looked at the influence of the site of anastomosis and the design of the stomach conduit. However, those studies included patients only in the 1980s, both stapled and hand-sewn methods were used, adenocarcinomas of the gastric cardia were not precluded, low intrathoracic and even abdominal anastomoses were encompassed, and no multivariate analyses were conducted to identify independent predisposing factors. In the present study, many of the factors were controlled for, all patients had intrathoracic squamous cell cancers, all anastomoses were constructed above the tracheal bifurcation, and only the hand-sewn method was used. The main findings of the present study were that with this anastomotic method, a leak rate of 3.2% was achieved with no consequent leak-related mortality. Benign anastomotic stricture was related to the site of the esophageal anastomosis and the design of the gastric conduit; a neck anastomosis and the distal stomach with incorporation of the stapled line in the anastomosis resulted in more stricture formation.

Controversies still exist with regard to the ideal site and method of anastomosis after esophagectomy. It is generally believed that cervical anastomoses have a higher leak rate compared with intrathoracic ones. Insufficiency was found in 10% to 26% of cervical anastomoses and less than 10% of thoracic anastomoses.[24-27] However, usually a leak in the neck is easier to manage by opening up the neck wound and is less lethal compared with one in the chest, where empyema can form and effective drainage is more difficult. Mortality rates associated with cervical and thoracic leaks were estimated to be approximately 20% and 60%, respectively.[24,28,29] Previous studies[22,23] from our institution with patients treated in the 1980s showed that leak-related deaths could reach 41%. With improvement in perioperative supportive and surgical care, anastomotic leaks are not as lethal.[30] In the present study, no leak-related mortality ensued.

Another factor related to the site of anastomosis is the possible increased incidence of recurrent laryngeal nerve injury when the anastomosis is performed in the neck, since dissection and retraction may damage the nerve at



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this level. Our recurrent laryngeal nerve injury rate seems slightly higher than that reported in the Western literature. This finding could be related to the high prevalence of middle and upper third tumors in our patients. The need to dissect in the middle and superior mediastinum and frequent anastomosis in the neck predisposed the patients to nerve injury. In addition, all of our patients underwent routine postoperative bronchoscopy, so the true incidence of nerve injury was documented. Our data were also prospectively captured. Series in which recurrent laryngeal nerve injury is diagnosed on clinical grounds of hoarseness alone may underestimate the true incidence of this complication because asymptomatic vocal cord palsy has been shown to occur in up to 20% of cases.[31] In our patients, 52% of the nerve injuries were transient.

When used as the substitute organ, the distal stomach was found to be more prone to anastomotic leak.[32,33] We have found previously that a stapled anastomosis using the distal stomach resulted in a higher leak rate compared with the whole stomach, but this effect was not seen with a hand-sewn anastomosis.[22] No stapled anastomosis was used in the current study, and no difference was found with the hand-sewn method comparing the 2 designs of the stomach conduit. When the colon conduit is used, a higher leak rate is expected.[17] The surgical procedure is more complicated, and the vascular supply to the colon loop is less reliable. The leak rate of colon loop was higher compared with the stomach or jejunum in the present study. However, the number of colon and jejunal conduits in the present study was too small to reach statistical significance.

Although benign stricture formation at the anastomosis is not a serious problem and can be dealt with by endoscopic dilation, it nevertheless results in dysphagia. This generates unnecessary anxiety for patients because the same symptom that led to the diagnosis of their cancer in the first place recurs, and there is the added discomfort of the endoscopic procedure. Multivariate analyses showed that reconstruction with the distal stomach and construction of the anastomosis in the neck were associated with a higher incidence of stricture. It is commonly believed that anastomotic stricture may be more prevalent for cervical anastomosis, which in turn is attributed to a higher incidence of leaks. Our stricture rates for cervical and intrathoracic anastomoses were 17.5% and 8.6%, respectively. Multivariate analysis, however, did not identify previous anastomotic leak as an important factor. This finding may in part be attributed to the low leak rate, but none of the patients who had leaks developed stricture. Other predisposing factors for stricture, apart from a higher leak rate for cervical anastomoses, include compression of the conduit at the thoracic inlet and relatively more tension at the anastomosis. Whether these factors could lead to more ischemia and thus stricture is difficult to prove. One method that proposed to lessen the chance of leak and stricture involves the use of a linear stapler to construct a "functional side-to-side esophagogastrostomy."[34] Results are satisfactory; however, when used in the neck, the method requires a substantial length of esophageal stump for its construction and thus may not be suitable for tumors that are located in the superior mediastinal segment, since an adequate resection margin is more difficult to obtain. Our hand-sewn technique has no limitation in esophageal length and also costs less.

The reason for a higher stricture rate using the distal stomach is not immediately apparent. The mere presence of the stapled line on one side of the anastomosis should not lead to more scarring and stricture. A recent study[35] showed that a larger cross-sectional area of anastomosis resulted in a lower leakage and stricture rate. We postulated that in our patients a larger disk of gastric fundus was removed for anastomosis using the whole stomach, compared with the distal stomach, which then led to a lower stricture rate. This hypothesis requires prospective confirmation. The colonic conduit may be more prone to stricture (3 of 8 patients), but the number was too small to make meaningful statistical interpretations.

The reported prevalence of anastomotic tumor recurrence varied from 2%[36] to 32%.[37] The propensity of esophageal cancer to spread intramurally and to have multiple separate tumors in the esophagus is well recognized and contributes in part to such recurrence. The prevalence of intraepithelial or subepithelial spread was as high as 46% and 54% in one report.[38] Our own pathologic study[39] using serial sectioning of resected specimens showed a 26% incidence of intramural metastasis. The pattern of spread may vary with the depth of invasion of the primary lesion. Contiguous intraepithelial spread frequently exists in early-stage cancer, whereas subepithelial lesions are found in advanced cancer. The deeper the wall penetration of the primary tumor, the farther away such spread can take place.[38] An inadequate resection margin may result in a histologically involved margin and hence subsequent recurrence. In this series, none of the patients who had microscopic tumor involvement of the resection margin developed anastomotic recurrence. Reasons may include the following. First, follow-up time may have been inadequate, since patients with a positive margin are more likely to have palliative resections and may die of other metastases before the development of anastomotic recurrence. Second, skip lesions, intramural spread, and submucosal embolization of tumors into the submucosal lymphatics may be missed by even conscientious pathologists, giving false-negative results. Third, only symptomatic patients underwent endoscopy, and the actual incidence of recurrence might be underestimated. Fourth, some anastomotic recurrences may be extrinsic tumor recurrences from regional lymph nodes that had infiltrated back into the anastomosis and did not truly originate from the esophageal wall itself. Distinction from true tumor origin at the esophageal margin is not possible. Instead of a histologically involved proximal resection margin, the chance of anastomotic recurrence seems more related to the length of the proximal resection margin attained at operation.[40]

Some surgeons advocate routine subtotal esophagectomy with cervical anastomosis to attain the longest resection margin, regardless of the site of the primary cancer. For tumors located in the superior mediastinal segment, a cervical anastomosis is mandatory. For tumors in the middle and lower esophagus, a choice exists. In our study, all patients who developed recurrences had a proximal margin of less than 5 cm. Taking into account shrinkage of the specimen after resec-



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tion,[41] as a guide to surgery, an in situ margin of approximately 10 cm should be the aim.

The addition of radiotherapy to a microscopically involved margin is also controversial. We were unable to demonstrate a relationship with radiotherapy because of our small number of patients; however, these results were similar to our previous report with a larger number of patients.[40]

In summary, the 1-layer, continuous technique of esophageal anastomosis is safe and economical, and subsequent anastomotic problems are infrequent. This approach is recommended for surgeons who perform esophageal surgery.

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