



Transhiatal Esophagectomy for Treatment of Benign and Malignant Esophageal Disease

Mark B. Orringer, M.D., Becky Marshall, M.D., Mark D. Iannettoni, M.D.

Section of General Thoracic Surgery, Department of Surgery, University of Michigan Medical Center, 2120 Taubman Health Care Center, 1500 E. Medical Center Drive, Box 0344, Ann Arbor, Michigan 48109, USA

Published Online: February 16, 2001

Abstract. Since our initial 1978 report, we have performed transhiatal esophagectomy (THE) in 1085 patients with intrathoracic esophageal disease: 285 (26%) benign lesions and 800 (74%) malignant lesions (4.5% upper, 22% middle, and 73.5% lower third/cardia). THE was possible in 97% of patients in whom it was attempted; reconstruction was performed at the same operation in all but six patients. The esophageal substitute was positioned in the original esophageal bed in 98%, stomach being used in 782 patients (96%) and colon in those with a prior gastric resection. Hospital mortality was 4%, with three deaths due to uncontrollable intraoperative hemorrhage. Major complications included anastomotic leak (13%), atelectasis/pneumonia prolonging hospitalization (2%), recurrent laryngeal nerve paralysis, chylothorax, and tracheal laceration (< 1% each). There were five reoperations for mediastinal bleeding within 24 hours of THE. Intraoperative blood loss averaged 689 ml. Altogether, 78% of the patients had no postoperative complications. Actuarial survival of the cancer patients mirrors that reported after transthoracic esophagectomy. Late functional results are good or excellent in 80%. Approximately 50% have required one or more anastomotic dilatations. With intensive preadmission pulmonary and physical conditioning, use of a side-to-side staple technique (which has reduced the cervical esophagogastric anastomotic leak rate to less than 3%), and postoperative epidural anesthesia, the need for an intensive care unit stay has been eliminated and the length of hospital stay was reduced to 7 days. We concluded that THE can be achieved in most patients requiring esophageal resection for benign and malignant disease and with greater safety and less morbidity than the traditional transthoracic approaches.

In 1978 the technique of transhiatal esophagectomy (THE) without thoracotomy was “rediscovered” when the results of this procedure in a series of 26 patients with both benign and malignant disease of the esophagus were reported [1]. The suggested advantages of this approach over standard transthoracic esophagectomy included (1) avoidance of a combined thoracoabdominal operation in a debilitated patient and presumably fewer postoperative pulmonary complications as a result; and (2) avoidance of an intrathoracic esophagogastric anastomotic leak with the attendant high mortality associated with mediastinitis.

Since that time there have been multiple reports debating the relative risks and merits of THE. Katariya and associates, in a collective review, discussed 1353 THE patients reported between

1981 and 1992 [2]. Nearly 70% of the papers cited in their report reviewed results in series of 50 patients or less and as such represented the surgeons’ the initial experience with the procedure. Gandhi and Naunheim reviewed the complications of THE in 1192 patients gathered from their collective review of papers published between 1992 and 1994 [3]. Four or more of these papers were series of 100 or more patients. We have recently reviewed our results of THE in 1085 patients with diseases of the intrathoracic esophagus requiring resection and reconstruction [4]. This is the most extensive reported experience with THE and provides the basis for this update on the role of THE in the treatment of benign and malignant esophageal disease.

Materials and Methods

Between 1976 and June 30, 1998 a total of 1085 patients requiring esophageal resection for diseases of the intrathoracic esophagus underwent THE on the General Thoracic Surgery Service at the University of Michigan Medical Center. A detailed esophageal resection database and follow-up obtained through personal interviews and examinations, letters, and telephone contacts with patients, families, and physicians have permitted a retrospective analysis of the results of these operations. Among these patients 285 (26%) had benign disease, and 800 (74%) had carcinoma (Table 1). The patients with benign disease ranged in age from 14 to 89 years (average 52 years), and the number of men (143) and women (142) was essentially the same. The 800 patients with carcinoma ranged in age from 29 to 92 years (average 64 years), and nearly four times as many men (651) as women (149) were affected. Twenty-two percent of these 1085 THE patients were 71 years of age or older. Consistent with the changing demographics of esophageal carcinoma in North America, adenocarcinoma was the predominant cell type, occurring in 555 (69%), in contrast to squamous cell carcinoma, which occurred in 225 (28%). Three percent had unusual cell types such as adenosquamous, signet ring cell, anaplastic, poorly differentiated, small-cell, and undifferentiated carcinoma.

During this time, only 15 patients in whom THE was attempted required conversion to a transthoracic esophagectomy because of

Table 1. Indications for transhiatal esophagectomy (1085 patients).

Indication	No.
Benign conditions	285 (26%)
Neuromotor dysfunction	93 (33%)
Achalasia	70
Spasm/dysmotility	22
Scleroderma	1
Stricture	75 (26%)
Gastroesophageal reflux	42
Caustic ingestion	19
Irradiation	4
Other	10
Barrett's mucosa with high grade dysplasia	54 (19%)
Recurrent gastroesophageal reflux	21 (7%)
Recurrent hiatal hernia	14 (5%)
Acute perforation	14 (5%)
Acute caustic injury	6
Other	8
Carcinoma of intrathoracic esophagus	800 (74%)
Upper third	36 (4.5%)
Middle third	177 (28.0%)
Lower third thoracic and/or cardia	587 (73.5%)

From Orringer et al. [4], with permission.

Table 2. Esophageal reconstruction after transhiatal esophagectomy (1085 patients).

Reconstruction	Benign (no.)	Carcinoma (no.)	Total
Immediate			
Cervical esophagogastrostomy	258	782	1040 (96%)
Posterior mediastinal	256	777	
Retrosternal	2	5	
Cervical esophagocolostomy	22	17	39 (4%)
Posterior mediastinal	16	10	
Retrosternal	6	7	
Delayed (2–8 weeks): retrosternal	4		4
None (esophagostomy, tube)	1	1	2
Total	285	800	1085

From Orringer et al. [4], with permission.

intrathoracic esophageal fixation or bleeding. Therefore despite previous radiation therapy or periesophagitis from prior operations or perforations, THE was possible in 98.6% of all of our patients in whom it was attempted. In four patients with acute caustic injuries, an emergent THE, cervical esophagostomy, and feeding jejunostomy were performed followed by delayed esophageal reconstruction 2 to 8 weeks later.

Esophageal resection and reconstruction were performed at the same operation in all but six patients (Table 2). Among these patients undergoing esophagectomy and reconstruction at one operation, the stomach was used as the esophageal substitute in 96% ($n = 1040$). Colon was used to replace the esophagus in 39 patients who had undergone prior gastric resection for peptic ulcer disease or whose stomach had been injured from caustic ingestion. The posterior mediastinum in the original esophageal bed was the preferred route for esophageal substitution and was used in all but 20 patients in whom tension-free positioning of the stomach for a cervical anastomosis was prevented by either posterior mediastinal fibrosis or residual tumor. The retrosternal route was used in these 20 patients.

As reported previously, cervical osteoarthritis may prevent ex-

tension of the neck; or a “bull neck” habitus in a markedly obese patient may limit the length of supraclavicular esophagus available for the cervical anastomosis. In such cases, a partial sternal split provides access to the cervical esophagus and allows THE and esophagogastric anastomosis behind the upper sternum, as was done in 100 (9%) of these patients [5].

The patients with carcinoma underwent removal of accessible subcarinal, paraesophageal, and celiac lymph nodes; but en bloc wide resection of the esophagus and adjacent lymph nodes was not performed routinely. The postsurgical TNM staging of the 800 esophageal carcinomas is shown in Table 3. All patients undergoing esophageal replacement with stomach underwent a pyloromyotomy, and a feeding jejunostomy was used routinely in all patients undergoing THE.

Results

Blood Loss

Three patients died from uncontrolled mediastinal bleeding during THE (one upper-third and two distal-third carcinomas). Inordinate intraoperative blood loss, ranging from 5850 to 18,440 ml, occurred in six other patients: three with a torn azygous vein during mobilization of middle-third carcinomas, two with intra-abdominal bleeding associated with portal hypertension from cirrhosis, and one from a splenic injury. Excluding these nine patients, intraoperative blood loss in the remaining 1076 patients averaged 689 ml. As the technique of THE has been refined and greater emphasis placed on division and ligation of lateral esophageal attachments under direct vision through the diaphragmatic hiatus, measured intraoperative blood loss has decreased from an average of 1166 ml for our first 50 THEs to 360 ml for our most recent 100 patients.

Intraoperative Complications

Nearly three-fourths of the patients required either a single or bilateral chest tube(s) because of entry into one or both pleural cavities identified intraoperatively after removal of the esophagus from the mediastinum and inspection of the pleura through the diaphragmatic hiatus (Table 4). Additional complications were relatively rare. Of four intraoperative membranous tracheal lacerations, three were repaired through a partial upper sternal split, and one required a right thoracotomy and direct suture of the carina. When the pyloroduodenal mucosa was entered during the performance of a pyloromyotomy, direct repair with 5-0 polypropylene buttressed with adjacent omentum was carried out successfully in each case.

Postoperative Complications

Five patients (< 1%) required a thoracotomy for control of *postoperative mediastinal bleeding* within 24 hours of THE. Hoarseness reflecting *recurrent laryngeal nerve injury* occurred in 7% (74 patients) and resolved spontaneously within 3 months in two-thirds of them. The hoarseness persisted in 24 patients, and 7 of them underwent vocal cord medialization procedures. With strict avoidance of placing metal retractors against the tracheo-esophageal groove during the cervical portions of the operation, the incidence of recurrent laryngeal nerve injury has fallen from

Table 3. Postsurgical TNM staging^a of 800 intrathoracic esophageal carcinomas.

Stage	Number, by tumor site				Total
	Upper third	Middle third	Lower third	Cardia	
0 ^b	8	15	45	4	72 (9.0%)
I	2	25	57	10	94 (11.8%)
IIA	10	48	109	22	189 (23.6%)
IIB	2	19	46	12	79 (9.9%)
III	9	54	170	63	296 (37.0%)
IVA	—	2	15	11	28 (3.5%)
IVB	5	14	17	2	39 (4.9%)
Unstaged ^c			2	1	3 (0.4%)
Total	36 (4.5%)	177 (22.1%)	462 (57.8%)	125 (15.6%)	800 (100.0%)

From Orringer et al. [4], with permission.

^aFleming, I.R., et al. (eds.) AJCC cancer staging handbook. In AJCC Cancer Staging Manual, 5th edition, Philadelphia, Lippincott-Raven, 1998.

^bIncludes 14 Tis + 59 T0 following prior chemotherapy, irradiation, or both.

^cIncludes one intraoperative death, one stromal carcinoma, and one T0NXM0 patient.

Table 4. Intraoperative complications of 1085 patients.

Complication	No.	%
Pleural entry	831	77
Splenectomy	34	3
Tracheal tear	4	<1
Hemorrhage	6	<1
Death	3	<1

an average of 32% during 1978–1982 when we performed an average of 23 THEs annually to 2% during the past 4 years when we have performed an average of 82 THEs annually.

Eighteen patients (< 1%) experienced a *chylothorax*, which was managed successfully in each case by transthoracic ligation of the injured thoracic duct within 7 to 10 days of operation as described previously [6]. Three percent of the patients experienced *abdominal wound infections* or *dehiscence*. Clinically significant *atelectasis* or *pneumonia* prolonging the hospital stay beyond 10 days was experienced by only 2% (17 patients).

The overall incidence of *anastomotic leak* after a cervical esophagogastric anastomosis was 13% (146 patients), 25% of whom ($n = 36$) had benign disease and 75% ($n = 110$) carcinoma. The incidence of anastomotic leak among the 1030 surviving patients with the stomach positioned in the posterior mediastinum was 13% (137 leaks) compared with 86% (6 leaks) in the 7 patients in whom the stomach was positioned retrosternally. Of the 146 cervical esophagogastric anastomotic leaks that occurred, 137 (94%) healed after opening the neck wound at the bedside and initiating wound packing. As described previously [7] esophageal dilations are begun within 7 to 10 days of an anastomotic leak to prevent the late development of a tight stenosis. Thirty-five percent (38 patients) of the 110 patients with carcinoma who experienced cervical esophagogastric anastomotic leaks postoperatively had undergone preoperative irradiation or chemoradiation therapy, which may have damaged the gastric fundus and contributed to impaired healing. In nine patients necrosis of the upper stomach occurred and required takedown of the anastomosis, resection of nonviable stomach, and cervical esophagostomy.

Mortality

The overall hospital mortality in this series of 1085 patients undergoing THE was 4.0% (44 deaths): 2.8% (8 deaths) among the

Table 5. Causes of hospital mortality among 1085 patients.

Cause of death	No. of deaths
Carcinoma (800 patients)	36 (4.5%)
Hepatic failure	6
Respiratory insufficiency	5
Myocardial infarction	4
Intraoperative bleeding	3
Pneumonia	3
Sepsis	3
Intestinal ischemia	3
Sudden death/cardiac arrest	3
Pulmonary embolus	2
Posterior mediastinal abscess	1
Retroperitoneal abscess	1
Unrecognized brain metastasis	1
Pyloromyotomy leak	1
Benign disease (285 patients)	8 (2.8%)
Sepsis	5
Myocardial infarction	1
Respiratory insufficiency	1
Portal vein thrombosis	1
Total	44 (4.1%)

285 with benign disease and 4.5% (36 deaths) among the 800 with carcinoma (Table 5).

Length of Stay

Of the 999 patients discharged alive after a THE and cervical esophagogastric anastomosis, 52% were discharged within 10 days of the operation, 28% within 2 weeks, and 11% within 3 weeks. The average length of stay after an uncomplicated THE has decreased during the past 2 years to 7 days.

Functional Results

Because of the relatively small number of patients undergoing colonic interpositions after THE, they are not included in this review of the functional results of esophageal substitution in which we analyze the presence and degree of dysphagia, regurgitation, and postvagotomy “dumping” (diarrhea and cramping). Because of their longer life expectancy, patients with benign disease undergoing esophageal resection and reconstruction provide a better indicator of the functional results of esophageal

substitution. Esophageal dilatation therapy is used liberally after a cervical esophagogastric anastomosis, patients being instructed to return for an outpatient anastomotic dilatation with a 46F or larger bougie if any degree of cervical dysphagia occurs after discharge from the hospital.

Esophageal Substitution with Stomach for Benign Disease. Of the 251 hospital survivors of THE and esophageal replacement with stomach for benign disease, 242 (96%) have follow-up information regarding functional results for up to 213 months (average 47 months). Because dilatation therapy is used liberally for any complaint of *cervical dysphagia*, only 56 of these patients (23%) have not had a single postoperative esophageal dilatation. However, at latest follow-up, 157 of the 242 patients followed (65%) have no dysphagia whatsoever, 38 (16%) occasional mild dysphagia that requires no treatment, 36 (15%) periodic dysphagia that requires an occasional esophageal dilatation but permits them to eat well and with satisfaction between treatments, and 11 (4%) “severe” dysphagia that requires daily or weekly dilatations. Most of these patients are able to swallow 46F or larger esophageal dilators.

No *regurgitation* of gastric contents has been reported by 146 patients (60%), mild regurgitation only when reclining or in the prone position after eating by 77 (32%) (this reflux is not a major problem for them), and nocturnal regurgitation of sufficient magnitude to require patients to sleep with the head of the bed propped up on blocks or in a reclining chair by 7% (18 patients). Pulmonary complications due to aspiration have been experienced by only one patient (< 1%).

Approximately 20% of patients undergoing THE and the accompanying vagotomy that occurs with it experience some degree of early postoperative postprandial cramping or diarrhea, the *dumping syndrome*. It generally resolves with time. At latest follow-up, 61% (147 patients) have no postprandial cramping or diarrhea; 20% (49 patients) have occasional mild postprandial diarrhea that requires no treatment; 7% (16 patients) experience “moderate” diarrhea requiring antidiarrheal medication such as diphenoxylate, loperamide, or Kaopectate; and 4% (10 patients) have “severe” postprandial diarrhea that requires regular medication. At latest follow-up, 38 patients (16%) experienced mild postprandial cramping that requires no treatment, and 9 patients (4%) have had intermittent postprandial cramping of sufficient severity to require regular use of antispasmodics.

The overall functional result in these patients with benign disease undergoing esophageal substitution with stomach is regarded as excellent (completely asymptomatic) in 71 (29%), good (mild symptoms requiring no treatment) in 93 (39%), fair (symptoms requiring occasional treatment such as a dilatation or antidiarrheal medication) in 68 (28%), and poor (symptoms requiring regular treatment) in 10 (4%).

Esophageal Substitution with Stomach for Carcinoma. Of the 748 hospital survivors of THE and a cervical esophagogastric anastomosis for carcinoma, 721 (96%) have been followed for up to 194 months (average 29 months). Again, with the liberal use of postoperative anastomotic dilatation, 378 (52%) have had at least one esophageal dilatation. In three patients dysphagia was severe enough and unresponsive to dilatation therapy, to warrant resection of the anastomotic stricture and construction of a new anastomosis. At the time of last follow-up, 80% (575 patients) have no dysphagia, 10% (71 patients) occasional mild dysphagia requiring

Table 6. Kaplan-Meier survival after transhiatal esophagectomy by tumor stage.

TNM stage	No. of patients	Survival (%)	
		2 Years	5 Years
0	72	83	51
I	94	84	59
IIA	189	50	22
IIB	79	51	29
III	296	32	10
IVA	28	17	7
IVB	39	6	0

From Orringer et al. [4], with permission.

no treatment, 8% (55 patients) moderate dysphagia for which occasional dilatation is needed, and 2% (20) severe dysphagia for which regular dilatation is required. Regurgitation of gastric contents is denied by 571 (79%); it is extremely infrequent and mild so the patients can still sleep horizontally with their heads on one or two pillows in 17% (124 patients); and it is moderately troublesome requiring elevation of the head of the bed on blocks or sleeping in a reclining chair in 3.5% (25 patients). Pulmonary complications of aspiration have been experienced by one patient (< 1%).

Postprandial cramping or diarrhea is not experienced by 530 (74%) at latest follow-up. Postprandial diarrhea does not occur in 571 patients (79%); it is mild, intermittent, and requires no treatment in 117 patients (16%). It is moderate, requiring occasional medication in 27 (14%); and it is severe, requiring regular anti-diarrheal medication in 6 (< 1%). Postprandial cramping pain is mild and requires no treatment in 83 patients (11.5%) or moderate requiring periodic antispasmodics in 13 (2%).

The overall functional result at latest follow-up of these patients with carcinoma is regarded as excellent in 389 (54%) (asymptomatic), good (mild symptoms requiring no treatment) in 204 (28%), fair (symptoms requiring occasional treatment) in 108 (15%), and poor (severe dysphagia requiring regular dilatation) in 20 (3%).

Survival of Patients with Carcinoma

Altogether, 764 (96%) of the 800 patients with carcinoma treated with THE left the hospital alive; 31 (4%) have been lost to follow-up. The remaining patients have been followed for up to 195 months after THE (mean follow-up 27 months).

The Kaplan-Meier actuarial survival in these patients was 67% at 1 year, 47% at 2 years, 34% at 3 years, 28% at 4 years, and 23% at 5 years. The site-dependent 5-year survival was 24% for upper-third tumors, 13% for middle-third tumors, and 26% for lower-third tumors.

Of the 800 patients with carcinoma, 217 (27%) received preoperative chemotherapy and radiation therapy either at the University of Michigan Medical Center or at outside hospitals. Among these patients, 49 (23%) had T0N0 tumors (complete responders) on final pathology. The 2-year actuarial survival for these 49 patients was 86% and the 5-year survival 48%. As expected, one of the key determinants of survival after THE has been the stage of the resected tumor; those with more advanced disease (stages III and IV) seldom survived 5 years (Table 6). THE was associated with a better survival for adenocarcinoma than for squamous carcinoma. Adenocarcinoma was associated with an overall sta-

tistically significant ($p < 0.01$) survival advantage. This advantage approached statistical significance ($p = 0.06$) at 5 years, with 24% of the patients with adenocarcinoma being alive compared with 17% of those with squamous carcinoma.

Discussion

This large single-institution experience demonstrates that excellent outcomes can be achieved when an operation is performed in relatively large volume by a single group of surgeons. Muller and associates, in a large collective review of the results of surgery in 76,911 patients with esophageal carcinoma, reported an overall reduction in postoperative mortality following esophageal resection for carcinoma of 50% during the last decade [8]. Muller et al. reported the lowest mortality ($11\% \pm 8\%$) in patients undergoing THE. In their collective review of the complications of THE in 1353 patients, Katariya and associates reported a 30-day mortality of 7.1% [2]. The review of Gandhi and Naunheim of 1192 more recent THE patients reported an average mortality of 6.7% [3]. The data from our University of Michigan series indicate that THE should be associated with a hospital mortality of less than 5%.

The initial concern expressed by critics of THE about the potential for excessive intraoperative hemorrhage with the operation has proved not to be justified. Reported incidences of massive intraoperative bleeding have ranged from 1.3% to 3.0%, and fewer than 1% of the University of Michigan patients sustained major intrathoracic hemorrhage requiring conversion to a thoracotomy for control. As experience was gained with transhiatal esophageal mobilization, direct clamping and ligation of periesophageal tissues utilizing long right angle clamps inserted through the diaphragmatic hiatus resulted in a substantially decreased blood loss. With our current blood loss averaging 360 ml, our blood bank no longer crossmatches blood for our THE patients on a routine basis.

The reported incidence of recurrent laryngeal nerve injury associated with THE has varied between and 9% and 11% [2, 3]. With careful avoidance of placing metal retractors against the tracheoesophageal groove during the cervical portions of the operation, recurrent laryngeal nerve injury should occur in fewer than 3% of patients undergoing THE.

Recent progress in decreasing the incidence of cervical esophago-gastric anastomotic leak following THE bears special emphasis. The reported incidence of cervical esophago-gastric anastomotic leak has averaged 12% to 15% [2, 3]. Multiple attempts by the authors to reduce the number of anastomotic leaks by altering the manual suturing technique (single layer, double layer, interrupted, running suture) have been unsuccessful. On the basis of our reported success using the Endo-GIA stapler for repair of esophageal perforations [9], the authors have developed a technique for utilizing this stapler for construction of a side-to-side stapled cervical esophago-gastric anastomosis [10]. Furthermore, every effort is now made to minimize trauma to the mobilized stomach being used to replace the esophagus. Laboratory studies have confirmed what has been evident from clinical observation for years: the tip of the mobilized stomach is relatively ischemic [11]. To avoid traumatizing an already vulnerable stomach, the authors now avoid the previously described rubber drain sutured to the tip of the stomach to draw it through the posterior mediastinum, as well as the previously advocated "tacking sutures" between the

prevertebral fascia and the gastric fundus [12]. Both sets of sutures result in ecchymosis and further trauma to the stomach, which may jeopardize anastomotic healing.

Once gastric mobilization and the transhiatal esophagectomy have been completed, the mobilized stomach is gently manipulated upward through the diaphragmatic hiatus and into the superior mediastinum by one hand until the tip can be palpated by the other hand inserted through the cervical incision. A Babcock clamp, which is not ratcheted closed to prevent trauma to the stomach, is gently inserted through the cervical incision and is used to grasp the stomach and help draw it into the neck wound. As soon as it is feasible, the tip of the stomach visible in the neck is grasped with the fingertips, and 4 to 5 cm of stomach is delivered above the level of the clavicles more by pushing from below in the chest than by pulling from above in the neck. A pink, healthy-appearing stomach, as is present in the abdomen after gastric mobilization, is a critical component of a successful THE. Through a small anterior gastrotomy and the divided cervical esophagus, the Endo-GIA II 30-3.5 stapler is applied and the anastomosis fashioned by firing the cutting mechanism of the stapler.

Among 114 consecutive patients undergoing this side-to-side stapled cervical esophago-gastric anastomosis using the Auto Suture Endo-GIA II stapler, the incidence of anastomotic leaks requiring drainage has been 2.6%. As a result of this more reliable anastomosis, the authors have been more comfortable with earlier hospital discharge after THE, and these patients are now being discharged an average of 7 days after their esophagectomy.

The importance of aggressive preoperative preparation of the patient for THE cannot be overemphasized. We are insistent that our patients who are candidates for THE totally abstain from cigarette smoking for 2 to 3 weeks before the proposed operation. Patients are issued an incentive spirometer at the time of their initial consultation, and they are instructed to use it on a regular basis preoperatively, to bring it with them when they come to the hospital for their operation, and to use it immediately after surgery. The patients are asked to walk 1 to 2 miles a day when possible preoperatively to condition themselves for early postoperative ambulation.

With attention to these details of preoperative preparation, avoidance of intraoperative trauma to the stomach as much as possible, and use of the side-to-side stapled anastomosis, the average hospitalization after THE in our patients has now decreased to 7 days and continues to fall, with some patients leaving the hospital as early as 5 to 6 days after surgery. Patients are typically extubated in the operating room, and postoperative epidural anesthesia greatly facilitates deep breathing. No intensive care stay is required.

Some still argue that the THE has the same impact on postoperative respiratory function as a combined thoracoabdominal esophagectomy. However, only 2% of our patients have experienced postoperative atelectasis or pneumonia that has prolonged their hospitalization beyond 10 days.

We believe that the experience with THE and a cervical esophago-gastric anastomosis over the past 20 years has demonstrated the superiority of the stomach over the colon as a long-term esophageal substitute. Relatively thick-walled upper alimentary tract organs such as the esophagus and stomach, whose function it is to transmit semisolid chewed food, do not develop the redundancy and tortuosity that is seen years after an intes-

tinal interposition in which the colon, a thin-walled, lower alimentary tract water absorption chamber, is required to serve a function for which it was not intended.

Although it is counterintuitive that there should be little significant gastroesophageal reflux when the stomach is brought into the chest and anastomosed to the cervical esophagus, reflux is not a major complaint in patients after THE and a properly performed end-to-end cervical esophagogastric anastomosis. Having a portion of the stomach in the chest and a portion in the abdomen, each influenced differently by the pleuroperitoneal pressure gradient, encourages gastroesophageal reflux, as is seen with a sliding hiatal hernia or an intrathoracic esophagogastric anastomosis. In contrast, when virtually the entire stomach has been mobilized into the thorax, as is the case after THE, so long as there is adequate gastric emptying there is little to encourage reflux of intrathoracic gastric contents into the cervical esophagus. Furthermore, the acute angle of entry created by the end-to-side anastomosis and the portion of stomach behind the cervical esophagus act to minimize reflux.

The greater relative simplicity of THE and a cervical esophagogastric anastomosis compared with colonic interposition, the lack of late development of redundancy of the intrathoracic stomach, the greater safety with which subsequent esophageal dilations, if necessary, can be performed, and the relatively low incidence of clinically significant gastroesophageal reflux are reasons we now prefer the stomach as the esophageal substitute for patients with benign or malignant disease who require esophageal resection and reconstruction. This conclusion is further justified by the overall functional results of esophageal substitution with stomach after THE, 68% having either an excellent or good result, 28% a fair result with relative mild symptoms requiring only occasional treatment, and only 4% a poor result with symptoms requiring regular treatment.

The appropriateness of THE as a "cancer operation" is still a subject that engenders controversy. Advocates of the traditional transthoracic approach or radical en bloc esophagectomy criticize THE because of its limitations in allowing mediastinal lymphadenectomy under direct vision. However, multiple reports show no significant difference in survival after THE for carcinoma compared with the more traditional thoracoabdominal approaches, which are associated with considerably more morbidity [13–18]. A few surgeons advocate radical en bloc esophagectomy with "complete" lymphadenectomy for esophageal carcinoma [19–22], but it has yet to be shown that more aggressive resection of esophageal cancers has survival benefit in most patients with this disease.

Recent reports suggest that occult cervical nodal metastases are present in 35% of patients undergoing esophagectomy for carcinoma of the thoracic esophagus deemed potentially "curable" [23, 24], so there seems to be even more evidence that esophageal carcinoma is often a systemic disease for which surgical cure is impossible. The use of combined preoperative chemotherapy and radiation therapy prior to esophagectomy has gained recent popularity, a number of phase II trials suggesting survival benefit, particularly when a complete histologic response (CR) is obtained [25–29] with such a multimodality approach. It is encouraging that of the 27% of our patients with esophageal cancer undergoing radiation therapy and chemotherapy prior to esophagectomy, nearly one-fourth were complete responders (T0N0 tumors); and among this group the 2-year survival was 86% and the 5-year survival 48%. The challenge is to identify patients in whom such

multimodality therapy will be of value and to avoid the cost and morbidity of this treatment in those for whom chemotherapy and radiation therapy is futile. Despite the current enthusiasm for multimodality therapy for esophageal cancer, the evidence favoring this approach is limited at best [30, 31].

Transhiatal esophagectomy is feasible in most patients requiring esophageal resection for benign or malignant disease. The operation may be of considerable technical difficulty in patients who have undergone a prior esophagomyotomy, which frequently results in adhesions between the exposed esophageal submucosa and the adjacent aorta. Careful direct dissection of the esophagus through the diaphragmatic hiatus in these patients is essential. Similarly, the patient with advanced megaesophagus has the potential for a technically more difficult THE. Not only does the enlarged sigmoid-shaped esophagus veer into the right chest, but dilation of the cervical esophagus may make it difficult to encircle it. THE for advanced achalasia is certainly not contraindicated, but greater care with hemostasis and the mediastinal dissection is required. In patients with middle-third esophageal carcinomas, preoperative assessment with bronchoscopy is mandatory to rule out tracheobronchial invasion, which precludes THE. When dissection of the mid-esophagus containing tumor is undertaken, experience is required to know when to persist with a dissection of the tumor through the diaphragmatic hiatus and when persistence in trying to separate the tumor from the airway or aorta is simply unsafe. At all times, the surgeon undertaking a THE must be prepared to switch to a transthoracic approach should the need arise. Irrespective of the method of removing the esophagus, whenever possible, we believe that a cervical esophagogastric anastomosis after positioning the stomach in the posterior mediastinum in the original esophageal bed is the optimal method of reconstruction.

The efficacy and safety of THE in patients undergoing esophagectomy for benign or malignant disease have been established. With mortality rates in experienced hands now consistently in the low single digits, the anastomotic leak rate less than 3%, and average hospitalization reduced to 7 days or less, THE with a cervical esophagogastric anastomosis must be regarded as perhaps the "best" method of esophageal resection and reconstruction regardless of the esophageal pathology.

Résumé

Depuis notre rapport initial en 1978, nous avons réalisé un abord transhiatal (ATH) chez 1,085 patients ayant une maladie de l'oesophage intrathoracique: 285 (26%) tumeurs bénignes et 800 (74%) tumeurs malignes (4.5% tiers supérieur, 22% tiers moyen, et 73.5% tiers inférieur/cardia). Un ATH a été possible chez 97% des patients pour lesquels il a été essayé; la reconstruction a été réalisée lors de la même opération chez tous les patients sauf six. Le conduit de remplacement oesophagien a été placé dans le lit de l'oesophage enlevé chez 98% des patients en utilisant l'estomac chez 782 patients (96%) et le côlon chez ceux qui avaient eu une résection gastrique antérieurement. La mortalité hospitalière a été de 4%, avec trois cas d'hémorragie peropératoire incontrôlable. Les complications majeures ont été la fistule anastomotique (13%), l'atélectasie/l'infection pulmonaire prolongeant l'hospitalisation (2%), la paralysie laryngée récidivante, le chylothorax et la déchirure trachéale (moins de 1% pour chacune des dernières). Il y avait cinq réinterventions pour

hemorragia mediastinal durante las primeras 24 horas después de la ATH. Las pérdidas sanguíneas fueron de 689 ml en promedio. El 78% de los pacientes no tuvieron complicaciones postoperatorias. La supervivencia actuarial de los pacientes refleja la reportada después de la esofagectomía por vía transtorácica. Los resultados funcionales son buenos o excelentes en el 80% de los pacientes. Alrededor del 50% de los pacientes necesitaron una o varias dilataciones de su anastomosis. Con una preparación preadmisión intensiva, pulmonar y física, el uso de una técnica de anastomosis mecánica latérolateral redujo el riesgo de fístula esofagostomica cervical a menos del 3% y el uso de sedación o de estancia en cuidados intensivos postoperatorios fue eliminado ya que el tiempo de estancia promedio fue reducido a 7 días. Conclusión: la ATH puede ser realizada en la mayoría de los pacientes con una resección esofagica para enfermedad benigna o maligna con una mayor seguridad y menor morbilidad que con los abordajes transtorácicos tradicionales.

Resumen

Desde nuestro informe inicial en 1978, hemos practicado la esofagectomía transhiatal (ETH) en 1.085 pacientes con enfermedad esofágica intratorácica: 285 (26%) con enfermedad benigna y 800 (74%) con enfermedad maligna (4.5% del tercio superior, 22% del tercio medio y 73.5% del tercio inferior/cardia). La ETH fue posible en el 97% de los pacientes en que se intentó; en casi todos se practicó la reconstrucción en el mismo acto quirúrgico, excepto en 6 casos. El sustituto esofágico fue posicionado en el lecho esofágico original en el 98% de los casos, utilizando estómago en 782 (96%) y colon en aquellos que habían sido sometidos a una resección gástrica previa. La mortalidad hospitalaria fue del 4%, con 3 muertes por hemorragia intraoperatoria incontrolable. Las complicaciones mayores incluyeron escape anastomótico (13%), atelectasis/neumonía causante de prolongación de la hospitalización (2%), parálisis del nervio laríngeo recurrente, quilotorax y laceración traqueal (menos del 1% cada una). Se registraron 5 reoperaciones por sangrado mediastinal en las primeras 24 horas. La pérdida intraoperatoria de sangre tuvo un promedio de 689 cc, el 78% de los pacientes no presentaron complicaciones postoperatorias. En los pacientes con cáncer, la supervivencia actuarial es igual a la de la esofagectomía transtorácica. Los resultados funcionales a largo plazo son buenos o excelentes en el 80% de los casos. Aproximadamente el 50% ha requerido una o más dilataciones de la anastomosis. Mediante acondicionamiento pulmonar y físico preoperatorio, el uso de la técnica de anastomosis latero-lateral mecánica, que ha reducido la tasa de escape anastomótico a menos del 3% y de la anestesia epidural postoperatoria, se eliminó la necesidad de UCI y la hospitalización se redujo a 7 días. Conclusión: la ETH puede practicarse en la mayoría de los pacientes que requieren resección esofágica por enfermedad benigna o maligna, con mayor seguridad y menor morbilidad que con los abordajes transtorácicos tradicionales.

Referencias

- Orringer, M.B., Sloan, H.: Esophagectomy without thoracotomy. *J. Thorac. Cardiovasc. Surg.* 76:643, 1978

- Katariya, K., Harvey, J.C., Pina, E., Beattie, E.J.: Complications of transhiatal esophagectomy. *J. Surg. Oncol.* 57:157, 1994
- Gandhi, S.K., Naunheim, K.S.: Complications of transhiatal esophagectomy. *Chest Surg. Clin. N. Am.* 7:601, 1997
- Orringer, M., Marshall, B., Iannettoni, M.D.: Transhiatal esophagectomy (THE): clinical experience and refinements. *Ann. Surg.* 230:392, 1999
- Orringer, M.B.: Partial median sternotomy: anterior approach to the upper thoracic esophagus. *J. Thorac. Cardiovasc. Surg.* 87:124, 1984
- Orringer, M.B., Bluett, M., Deeb, G.M.: Aggressive treatment of chylothorax complicating transhiatal esophagectomy without thoracotomy. *Surgery* 104:720, 1988
- Orringer, M.B., Lemmer, J.H.: Early dilatation in the treatment of esophageal disruption. *Ann. Thorac. Surg.* 42:536, 1986
- Muller, J.M., Erasmi, H., Stelzner, M., Zieren, U., Pichlmaier, H.: Surgical therapy of esophageal carcinoma. *Br. J. Surg.* 77:845, 1990
- Whyte, R.I., Iannettoni, M.D., Orringer, M.B.: Intrathoracic esophageal perforation: the merit of primary repair. *J. Thorac. Cardiovasc. Surg.* 109:140, 1995
- Orringer, M.B., Marshall, B., Iannettoni, M.D.: Eliminating the cervical esophagogastric anastomotic leak with a side-to-side stapled anastomosis. *J. Thorac. Cardiovasc. Surg.* 119:277, 2000
- Jacob, C.A., Zieren, H.U., Zieren, J., Muller, J.M.: Is tissue oxygen tension during esophagectomy a predictor of esophagogastric anastomotic healing. *J. Surg. Res.* 74:161, 1998
- M.B. Orringer: *Transhiatal esophagectomy without thoracotomy*. In Shackelford's *Surgery of the Alimentary Tract*, 4th edition, vol. I, Orringer, M.B., Zuidema, G.D., editors, Philadelphia, Saunders, 1996, pp. 414-445
- Bolton, J.S., Sardi, A., Bowen, J.C., Ellis, J.K.: Transhiatal and trans-thoracic esophagectomy: a comparative study. *J. Surg. Oncol.* 51:249, 1992
- Bolton, J.S., Ochsner, J.L., Abdoh, A.A.: Surgical management of esophageal cancer: a decade of change. *Ann. Surg.* 51:475, 1994
- Gertsch, P., Vauthey, J.N., Lustenberger, A.A., Friedlander-Klar, H.: Long-term results of transhiatal esophagectomy for esophageal carcinoma: a multivariate analysis of prognostic factors. *Cancer* 72:2312, 1993
- Horstmann, O., Verreet, P.R., Becker, H., Ohmann, C., Roher, H.D.: Transhiatal esophagectomy compared with transthoracic resection and systemic lymphadenectomy for the treatment of esophageal cancer. *Eur. J. Surg.* 161:557, 1995
- Moon, M.R., Schulte, W.J., Haasler, G.B., Condon, R.E.: Transhiatal and transthoracic esophagectomy for adenocarcinoma of the esophagus. *Arch. Surg.* 127:951, 1992
- Gluch, L., Smith, R.C., Bambach, C.P., Brown, A.R.: Comparison of outcomes following transhiatal or Ivor Lewis esophagectomy for esophageal carcinoma. *World J. Surg.* 23:271, 1999
- Altorki, N.K., Girardi, L., Skinner, D.B.: En bloc esophagectomy improves survival for stage III esophageal cancer. *J. Thorac. Cardiovasc. Surg.* 114:948, 1997
- Hagan, J.A., Peters, J.H., DeMeester, T.R.: Superiority of extended en bloc esophagogastric resection for carcinoma of the lower esophagus and cardia. *J. Thorac. Cardiovasc. Surg.* 106:850, 1993
- Akiyama, H., Tsurumaru, M., Udagawa, H., Kajiyawa, Y.: Radical lymph node dissection for cancer of the thoracic esophagus. *Ann. Surg.* 220:364, 1994
- Lerut, T., DeLeyn, P., Coosemans, W., VanRaemdonck, D., Scheys, I., LeSaffre, E.: Surgical strategies in esophageal carcinoma with emphasis on radical lymphadenectomy. *Ann. Surg.* 216:583, 1992
- Altorki, N.K., Skinner, D.B.: Occult cervical nodal metastasis in esophageal cancer: preliminary results of three-field lymphadenectomy. *J. Thorac. Cardiovasc. Surg.* 113:540, 1997
- Kato, H., Tachimori, Y., Watanabe, H., Iizuka, T., Terui, S., Itabashi, M., Hirota, T.: Lymph node metastasis in thoracic esophageal carcinoma. *J. Surg. Oncol.* 48:106, 1991
- Forastiere, A.A., Orringer, M.B., Perez-Tamayo, C., Urba, S.G., Zahurak, M.: Preoperative chemoradiation followed by transhiatal esophagectomy for carcinoma of the esophagus: final report. *J. Clin. Oncol.* 11:1118, 1993
- Seydel, H.G., Leichman, L., Byhardt, R., Cooper, J., Herskovic, A., Libnock, J., Pazdur, R., Speyer, J., Tschan, J.: Preoperative radiation and chemotherapy for localized squamous cell carcinoma of the

- esophagus: an RTOG study. *Int. J. Radiat. Oncol. Biol. Phys.* 14:33, 1988
27. Poplin, E., Fleming, T., Leichman, L., Seydel, H.G., Steiger, Z., Taylor, S., Vance, R., Stuckey, W.J., Rivkin, S.E.: Combined therapies for squamous cell carcinoma of the esophagus: a Southwest Oncology Group study (SWOG-8037). *J. Clin. Oncol.* 5:622, 1987
 28. Naunheim, K.S., Petruska, P.S., Roy, T.S., Andrus, C.H., Johnson, F.E., Schlueter, J.M., Baue, A.E.: Preoperative chemotherapy and radiotherapy for esophageal carcinoma. *J. Thorac. Cardiovasc. Surg.* 103:887, 1992
 29. Sauter, E., Coia, L., Keller, S.: Preoperative high-dose radiation and chemotherapy in adenocarcinoma of the esophagus and esophagogastric junction. *Ann. Surg. Oncol.* 1:5, 1993
 30. Walsh, T.N., Noonan, N., Hollywood, D., Kelly, A., Keeling, N., Hennessy, T.P.: A comparison of multimodal therapy and surgery for esophageal adenocarcinoma. *N. Engl. J. Med.* 335:462, 1996
 31. Urba, S., Orringer, M.B., Turrisi, A., Whyte, R., Iannettoni, M., Forastiere, A.: A randomized trial comparing surgery to preoperative concomitant chemoradiation plus surgery in patients with resectable esophageal cancer: update analysis. *Proc. ASCO* 16:277a, 1997