

Transhiatal Radical *En Bloc* Dissection of the Low- and Mid-Mediastinum for Cardioesophageal Carcinomas

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Summary. An innovative operative technique of transhiatal radical *en bloc* dissection of the posterior low- and mid-mediastinum is described. This technique is applied in one of the dissecting phases of surgery for carcinomas of the esophagus and gastric cardia. The key aspects of the technique are: 1) sufficient dissection of the pericardiophrenic ligament; and 2) mediastinal pleurotomy and detachment of the pulmonary ligaments. These two key maneuvers not only warrant an excellent visualization of the posterior low- and mid-mediastinum but enable a complete *en bloc* dissection of these mediastinal fields under direct vision. During the past eight years from 1990 to 1997, a total of 214 patients with carcinoma of the esophagus or gastric cardia underwent the transhiatal mediastinal dissection. There were no serious complications directly attributed to the dissection except for two cases (0.9%), thus exhibiting excellent results. The procedure has comprehensive feasibility as a means for dissection of the posterior low- and mid-mediastinum in surgery for carcinomas of the esophagus and gastric cardia which necessitate dissection of these particular mediastinal compartments.

Key words—Carcinoma of the esophagus and gastric cardia, Transhiatal dissection without thoracotomy, Dissection of the low- and mid-mediastinum.

INTRODUCTION

Dissection of lymph nodes distributed in the posterior low- and mid-mediastinum is thought to be indispensable in radical surgery for carcinoma involving the lower esophagus and gastric cardia^{1,2}. It is also

deemed to be worthwhile for carcinomas of the upper or middle thoracic esophagus as they involve lymph nodes in these mediastinal fields with significant incidence^{3,4}.

During the past decades, transthoracic procedures have been conventionally carried out for dissection of the posterior low- and mid-mediastinum in radical surgery of esophagogastric malignancies. Left transthoracic procedures have been preferred for carcinoma of the lower esophagus and gastric cardia⁵⁻⁸. On the other hand, right thoracotomy has been the choice of surgical approach for dissection of these mediastinal fields when the carcinoma is located in the middle or upper thoracic esophagus^{3,8}. There is, however, a counterpart for dissection of the posterior low- and mid-mediastinum-transhiatal procedures without thoracotomy^{1,9,10}, recently becoming widespread in practice. We here describe an advanced transhiatal technique for radical *en bloc* dissection of these particular mediastinal compartments which we have been employing since 1990 in surgery for carcinomas of the esophagus and gastric cardia stressing its comprehensive feasibility in surgery for carcinomas which necessitates mediastinal dissection.

TECHNIQUE

Median phrenotomy and dissection of the pericardiophrenic ligament: Exposure of the low-mediastinum (Fig. 1)

The patient is laid on the table in the supine position. The abdominal cavity is entered through an upper midline incision. The lateral segment of the liver is mobilized by severance of the left triangular ligament to expose the esophageal hiatus. The lesser

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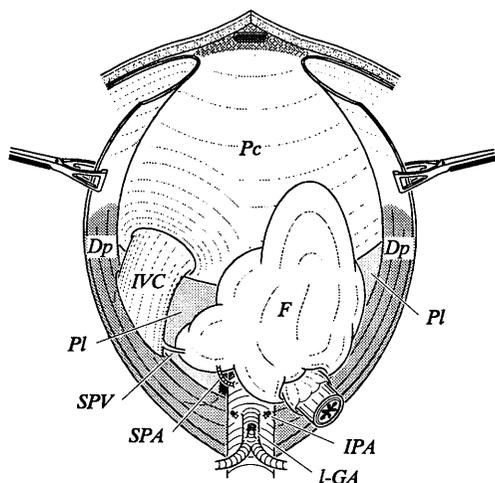


Fig. 1. Dissection of the pericardiophrenic ligament and exposure of the low-mediastinum following median phrenotomy: Fatty tissue distributed in the low-mediastinum (F) is being dissected, exposing the pericardium (Pc), inner faces of the severed diaphragm (Dp), *Pars pericardiaca* of the mediastinal pleurae (PI) and suprarenic *Inferior Vena Cava* (IVC). SPV and SPA, superior phrenic vein and artery, IPA and I-GA, inferior phrenic and left gastric arteries (cut stumps).

omentum is divided close to the liver, and the peritoneum covering the *Recessus superior* of omental bursa is removed. After ligation and severance of the left inferior phrenic vein at midline, a total median phrenotomy is made. When the tumor is located in the lower esophagus and gastric cardia, the perihial diaphragm is resected in a cuff in continuity with the esophagus as described elsewhere^{1,10}.

With lateral traction of both cut edges of the severed diaphragm by alligator forceps, dissection of the pericardiophrenic ligament is sufficiently made; fatty tissues around the pericardium and inner faces of the severed diaphragm are dissected. Clearance of fatty tissues overlying the *Pars pericardiaca* of mediastinal pleura of both sides and around the suprarenic *Inferior Vena Cava* (IVC) are also made, exposing these structures. The superior phrenic veins are clipped and severed at the confluences. Crossing muscle fibers of the diaphragmatic crura forming the aortic hiatus are resected with suture-ligatures to bare the aorta and celiac

axis. The superior and inferior phrenic arteries and left gastric artery are ligated and divided at their origins, respectively, as are the superior phrenic and coronary veins. At this point, the distal part of lower esophagus and gastric cardia along with surrounding soft tissues including the supra- and infra-diaphragmatic lymph nodes¹¹ and those distributed around the esophageal hiatus and celiac axis are separated from the aorta and diaphragm, and a wide exposure of the low-mediastinum is achieved.

Mediastinal pleurotomy and detachment of the pulmonary ligaments: Opening of the posterior mediastinum (Fig. 2)

Longitudinal incisions to the *Pars pericardiaca* of mediastinal pleurae are made in both sides, and the chest cavities are entered. Each incision is placed several centimeters lateral to the reflection of the mediastinal pleurae to the visceral pleurae, where the pulmonary ligament is formed, unless tumor involvement to these structures is recognized. The pulmonary ligaments are then detached bilaterally with clip-hemostases, and the inferior lobes of the lung are mobilized. The posterior low-mediastinum is widely opened by pressing the pericardium upward and both inferior lobes of the lung aside with blade retractors. There is no need for collapse of the lungs. The prevertebral and preaortic mediastinal pleurae are then incised just lateral to the azygos vein and along the posterolateral face of the aorta, respectively. Three incision lines on both sides, two in the mediastinal pleurae and one to the pulmonary ligament, are started from just above the diaphragm and extended towards the pulmonary hilus where they are to be met in the following maneuvers.

Upward extension of the mediastinal dissection (Fig. 3)

In the dorsal aspect, the preaortic and prevertebral fatty tissues are cleared craniad exposing the anterior semicircle of the descending aorta and prevertebral structures such as the thoracic duct, azygos system, and intercostal vessels. All the esophageal and mediastinal arteries and any thread connecting to the thoracic duct must be clipped and divided. Anterolaterally, dissection is advanced by removing fatty tissues overlying both atria (in the pericardium), and the inferior pulmonary veins and inferior lobar bronchi of both sides. Mediastinal fatty tissues including the middle and lower paraesophageal and posterior mediastinal lymph nodes¹² and strips of the mediastinal pleurae are dissected in continuity with the esophagus.

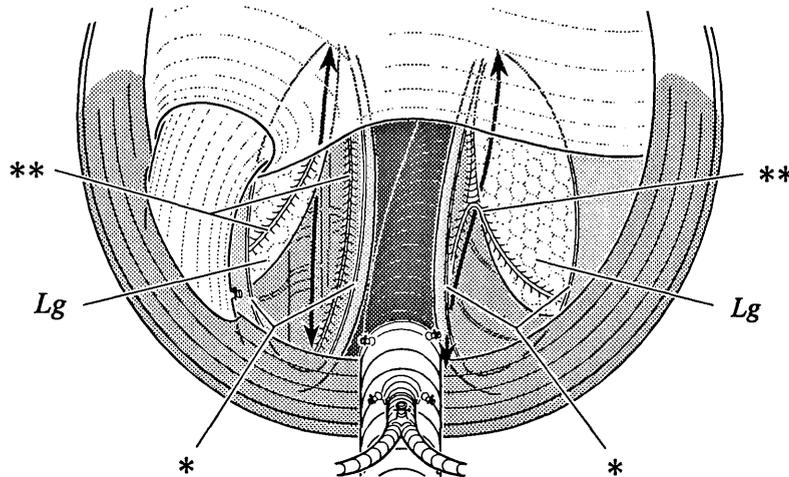


Fig. 2. Exposure of the posterior mediastinum by mediastinal pleurotomy and detachment of the pulmonary ligament: The *Pars pericardiaca* of mediastinal pleurae of both sides has been incised longitudinally. Detachment of the pulmonary ligament has been completed in the right and is in progress in the left. The prevertebral and preaortic mediastinal pleurae are to be incised as indicated by thick lines with arrow heads at both ends, Lg, lung; * and **, cut edges of the *Pars pericardiaca* of mediastinal pleurae and pulmonary ligament.

Completion of the mediastinal dissection (Fig. 4)

Dissection finally reaches the esophageal wall, around which the vagi are to be divided at the level just below the tracheal bifurcation unless a right thoracotomy is to be made later. When planned, mainly for patients with carcinoma of the upper or middle thoracic esophagus, the dissection is successfully completed in the right intrathoracic maneuvers.

At completion of the dissection, the entire fatty tissues including lymph nodes distributed in the posterior low- and mid-mediastinum up to the tracheal bifurcation are removed *en bloc* in continuity with the esophagus.

Additional maneuvers

The above-mentioned transhiatal dissection of the mediastinum was originally carried out in combination either with a lower or a thoracic esophagectomy with proximal or total gastrectomy. The extent of resection of the stomach and esophagus varies according to the location and extent of the tumor. When a lower esophagectomy is indicated, the esoph-

agus is divided at an appropriate intrathoracic level. When a thoracic esophagectomy is planned, the upper thoracic esophagus is dissected via an additional right thoracotomy or by blunt finger technique. Reconstructive procedure is adjusted to the type of resection. We usually adopt an intrathoracic esophagojejunostomy after a lower esophagectomy with total gastrectomy. A gastric tube or a colon segment is pulled-up and anastomosed to the cervical esophagus at the left neck through the posterior mediastinal or retrosternal route following thoracic esophagectomy (Table 1).

Two long flexible chest drains are placed: one in the right via prevertebral space, and the other in the left via preaortic region. They are guided out to the anterior chest wall through the space between the pericardium and severed diaphragm which is eventually closed by sutures. When alimentary tract continuity is secured through the posterior mediastinum, the closure should be loose enough not to compress the vascular pedicles of the organ used for reconstruction; otherwise, it should be as air-tight as possible.

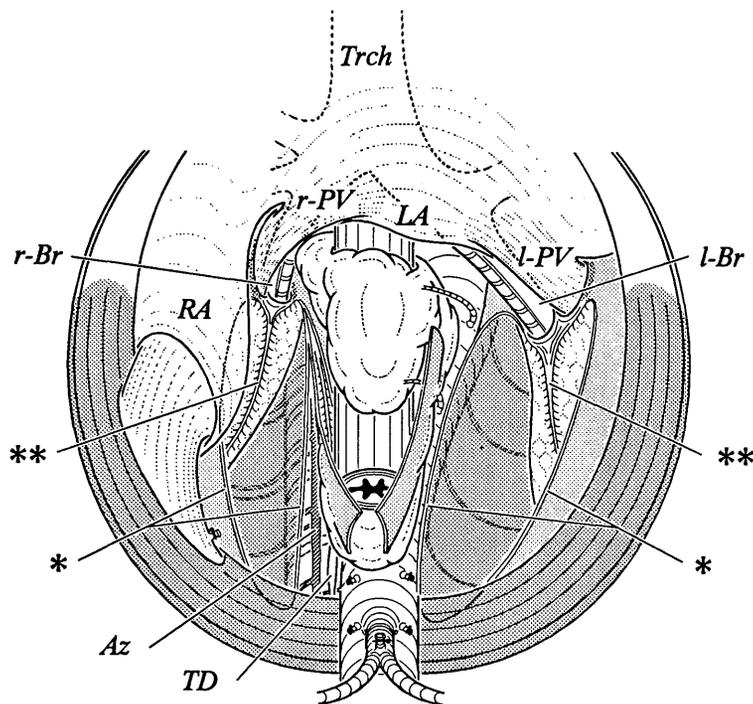


Fig. 3. Upward extension of the mediastinal dissection: Dissection of the right mediastinum is in progress in the figure. Strips of the mediastinal pleurae wrapped with mediastinal fatty tissue are being resected in continuity with the esophagus. RA and LA, right and left atria (in the pericardium), r-PV and l-PV, right and left inferior pulmonary veins, r-Br and l-Br, right and left inferior lobar bronchi, Az, azygos vein, TD, thoracic duct, Trch:trachea; * and **, cut edges of the *Pars pericardiaca* of mediastinal pleurae and pulmonary ligament.

INTRA- AND POSTOPERATIVE MANagements

Excessive compression of the heart, the suprahepatic IVC, or the inferior pulmonary veins must be avoided during the dissection to prevent cardiac embarrassment. Continuous monitoring of blood pressure through an artery line is essential. The patient is ordinarily extubated after recovery from anesthesia unless she undergoes additional maneuvers through a right thoracotomy for which appropriate respiratory care will be necessary. Each drain placed in the chest cavity is connected to underwater suction and left in place until the drainage decreases to less than 50 ml/day. In the other points, the intra- and postoperative managements are basically the same as in the case of transhiatal esophagectomy without aggressive mediastinal dissection¹³.

CLINICAL OUTCOME

During the past eight years from 1990 to 1997, a total of 214 patients with a median age of 63 years (range 40 - 85) underwent transhiatal mediastinal dissection at our institution. One hundred and sixty-eight patients (78.5%) had carcinoma of the thoracic esophagus: 104 patients in the upper or middle thoracic esophagus, and 64 in the lower esophagus. Carcinoma of the lower esophagus and gastric cardia, or carcinoma involving the esophagogastric junction, accounted for 46 patients (21.5%). Thoracic esophagectomy was performed in 195 patients (91.1%), among whom 109 patients (50.9%) underwent right thoracotomy for dissection of the upper mediastinum as a part of a systematic lymphadenectomy for esophageal carcinoma³. In the remaining 86 patients, the upper thoracic esophagus was dissected by blunt

finger technique without thoracotomy. Lower esophagectomy with total gastrectomy and intrathoracic esophagojejunostomy was carried out in 19 patients (8.9%), exclusively those with carcinoma of the lower esophagus and gastric cardia. Cervical esophagogastrostomy was the choice of reconstructive procedure whenever the stomach was available, and was carried out in 167 patients (78.0%). Colon segment interposition was applied in 28 patients (13.1%) who had undergone prior gastric surgery or underwent total gastrectomy at surgery. Table 1 summarizes the tumor location and operative procedures in the 214 patients undergoing the transhiatal mediastinal dissection.

Two patients (0.9%) died of acute myocardial infarction within 30 days after surgery. Seven patients (3.3%) died in the hospital between 41 days and 10 months after surgery; two died of postoperative complication (aortotracheal fistula in one and rupture of the left renal artery pseudoaneurysm in the other) and 5 died of early relapse of the disease. Hence the total in-hospital mortality was 4.2%. However, including these 9 patients, there were no serious complications directly attributed to the transhiatal dissection except for two cases (0.9%); one was intraoperative massive bleeding due to injury of an intercostal artery, and the other was postoperative chylothorax.

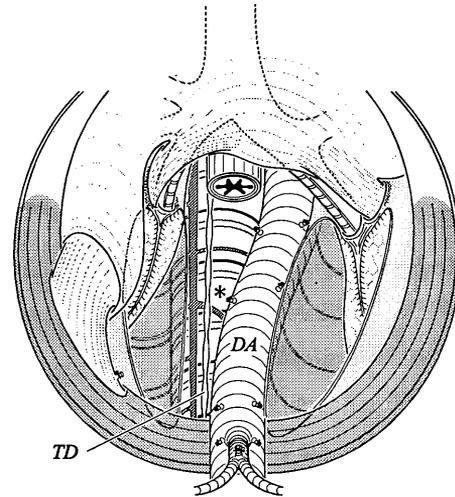


Fig. 4. Mediastinal view at completion of the transhiatal dissection: DA, descending aorta; TD, thoracic duct; *, 9th thoracic vertebra.

Table 1. Tumor location and surgical procedures in 214 patients undergoing the transhiatal mediastinal dissection

Tumor location	Upper or middle thoracic esophagus	104	
	Lower esophagus	64	
	Lower esophagus and gastric cardia (Tumor involving esophagogastric junction)	46	
Extent of resection	Esophagus	Thoracic esophagectomy	195
		via right thoracotomy	109
		blunt esophagectomy	86
		Lower esophagectomy	19
	Stomach ^{a)}	Proximal gastrectomy	168
Total gastrectomy		38	
Reconstruction	Cervical esophagogastrostomy	167	
	Colon interposition	28	
	Esophagojejunostomy ^{b)}	19	

a): Seven patients had undergone distal gastrectomy prior to surgery and the remnant stomach was left *in situ*. One had undergone total gastrectomy.

b): Eighteen were in Roux-en-Y fashion and one in jejunal interposition.

DISCUSSION

Transhiatal approach to the posterior mediastinum was originally proposed by Wangensteen in 1951¹⁴. He introduced a median phrenotomy with partial median sternotomy in surgery for esophageal achalasia. Later, in the 1980's, several workers^{9,15,16} applied transhiatal approaches with their own modifications to surgery for carcinomas of the esophagus and gastric cardia as an alternative to thoracotomy approaches. Among them, Finley et al.¹⁹ established a basic operative technique of transhiatal dissection of the mediastinum.

We employed Wangensteen's approach for radical dissection of the posterior mediastinum during the 1980's¹⁷. In 1990, on the basis of accumulated experience and a full understanding of the anatomical correlation among mediastinal structures, we considerably modified the dissection technique. The modifications, which form the key aspects of our present technique; consist of the following two principal maneuvers: 1) sufficient dissection of the pericardiophrenic ligament under median phrenotomy without sternotomy, and 2) mediastinal pleurotomy and detachment of the pulmonary ligaments. Because these ligamentous structures and mediastinal pleurae settle the heart and lung in place and hence restrict a sufficient exposure of the mediastinum, these two maneuvers bring about ample and excellent visualization of the posterior low- and mid-mediastinum. They also enable a complete *en bloc* dissection of these particular mediastinal fields under direct vision from the standpoint of a close anatomical correlation between the esophagus and its mediastinal lymphatic drainage as had been stressed by Skinner⁸.

Transhiatal procedures had been thought to exert less influence on pulmonary function than transthoracic procedures. It had been reported that postoperative pulmonary complications after transhiatal esophagectomy were significantly less frequent than after transthoracic esophagectomy¹⁸. This should be one of the reasons that the postoperative recovery of the patients undergoing transhiatal esophagectomy was so prompt as to allow them to be typically discharged around the 10th postoperative day^{10,13}. Although the transhiatal procedure presented here is considerably more aggressive than those previously published, it inherits this property native to transhiatal procedures because entering chest cavities by pleurotomy does not affect pulmonary function seriously^{9,10}. Our transhiatal technique enables a secure and facile dissection of the posterior low- and mid-mediastinum with minimal influence to the pulmo-

nary function. This affords wide and safe application of the procedure to patients with high surgical risk, especially those with significant pulmonary compromise including severe intrathoracic adhesions, for whom a thoracotomy should be avoided. It is also a major benefit that our procedure is performed along with intraabdominal maneuvers under a wide-open surgical field from the mid-mediastinum to the abdomen. This provides flexibility in selection of the type of resection of the esophagus and stomach, and of reconstructive procedure (Table 1). This also makes it easy to cope with combined resection of any local organ or structure: the spleen, tail of the pancreas, diaphragmatic crura, pericardium, inferior lobes of the lung, thoracic duct and other prevertebral structures can be resected safely according to the extent of tumor involvement.

The potential disadvantage of transhiatal procedures, including ours, may be the incomplete clearance of subcarinal lymph nodes, as had been pointed out earlier⁹. This could be one of the reasons why even recent workers have mainly adopted their transhiatal techniques to patients with carcinoma of the lower esophagus and gastric cardia^{1,10}. However, this possible shortcoming can be ameliorated by additional maneuvers through a right thoracotomy. As is evident from our own experience mentioned above, the minimal effect of transhiatal procedures on the pulmonary function permits a right thoracotomy when it is indicated⁹, unless the patient is not suited for a thoracotomy. From a different viewpoint, this indicates that the time requiring transthoracic maneuvers, during which the lung has to be desufflated or collapsed, can be definitely shortened when the transhiatal procedure precedes thoracotomy. This should be considered one of the major benefits of our transhiatal procedure.

Considering the evolution of transhiatal operation, the operative technique described here is not our invention because its fundamentals had been established by the other workers^{9,14-16}. However, we are confident that our procedure is one of the most sophisticated techniques for transhiatal radical *en bloc* dissection of the posterior low- and mid-mediastinum. The transhiatal procedure presented here has comprehensive feasibility when applied as a means for dissection of the posterior low- and mid-mediastinum in surgery for carcinomas of the esophagus and gastric cardia, and may well be an strategic alternative to conventional transthoracic procedures.

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