

CARCINOMA OF THE MIDTHORACIC ESOPHAGUS*

ITS TREATMENT BY RADICAL RESECTION AND HIGH INTRATHORACIC ESOPHAGOGASTRIC ANASTOMOSIS

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ANY OPERATIVE PROCEDURE which is intended to be applied in the treatment of carcinoma of the esophagus, at whatever level, must be based upon the two-fold aim of prolongation of life, looking towards the possibility of cure, and the provision of relief from the distress which results from the obstruction produced by the growth.

Until recently the only practical method available for use in the removal of a carcinoma located in the middle half of the thoracic portion of the esophagus was the Torek operation.¹ This procedure has, however, been shown to be unsatisfactory when measured by the above criteria.

In the first respect, the Torek operation is inadequate as a cancer operation. It is a well-established principle in the treatment of carcinoma that in addition to a wide excision of the primary tumor, it is essential to remove as large a number of the regional nodes as possible. If Torek's original technic is followed, two important groups of regional lymph nodes are not removed. These are the subdiaphragmatic paracardial nodes and the group of nodes found in relation to the left gastric vessels. Both of these groups, in addition to those located around the lower thoracic portion of the esophagus, are frequently involved by metastases (Table I). The importance of remov-

TABLE I

CARCINOMA OF THE MIDTHORACIC ESOPHAGUS

Frequency and Distribution of Lymph Node Metastases in 32 Patients who had Resection and Anastomosis

Nodes not involved.....	9
Nodes involved.....	23
Hilum of lung.....	7
Peri-esophageal.....	15
Paracardial.....	13
Near left gastric vessels.....	16

ing these nodes in the performance of the operation is confirmed by the fact that they were found to be involved in 50 per cent of the cases in this series of 32 radical resections. It is only the lower thoracic nodes which are removed in the classical Torek operation.

In the second place, the failure of the Torek procedure to provide satisfactory palliation, even if an external esophagoplasty is successfully completed, is obvious to those who have had experience with its use.² Table II summarizes the results obtained from the application of the Torek procedure in

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TABLE II

EXPERIENCE WITH THE TOREK OPERATION AT THE MASSACHUSETTS GENERAL HOSPITAL

Number of operations.....	14
Postoperative deaths.....	2
Survivals.....	12
External esophagus not begun (all patients dead).....	4
External esophagus begun.....	8
Died before completion.....	4
External esophagus completed.....	4
Died subsequently.....	3
Alive and well.....	1

14 cases of carcinoma of the midthoracic esophagus. The immediate post-operative mortality is not prohibitive (two cases). But its poor result from the standpoint of cure is evident from the fact that all but one patient have died of metastatic or recurrent disease. The unsatisfactory palliative result is reflected by the fact that of the eight patients in whom an external esophago-plasty was begun, four died of metastases before the procedure could be completed. Of the remaining four in whom the external esophagus was finally established, two died soon after the completion of the surgical program. Of the two who remained well, one has since died and one is alive and well almost six years after the operation. These results are far from satisfactory.

The development of a satisfactory technic for the radical resection of the local disease, including the excision of at least three of the four groups of regional nodes which may be invaded, offers greater promise of producing a cure in these cases. But of equal, if not greater, importance is the fact that after a high primary intrathoracic esophagogastric anastomosis has been performed, the patient is able to swallow normally. The palliation afforded by this procedure, even if death should occur six months to a year, or more, later as a result of distant metastases, makes this operation infinitely superior to the Torek procedure.

DESCRIPTION OF THE OPERATION: ESOPHAGECTOMY FOLLOWED BY HIGH INTRATHORACIC ESOPHAGOGASTRIC ANASTOMOSIS

Intratracheal ether-oxygen anesthesia is used. The patient is placed on his right side with the left arm held forward, the hand in front of his face. The left side of the chest is made to arch upwards by bending the operating table at an angle. Intravenous infusions of saline and transfusions of blood are given as necessity demands during the procedure, using a hand or forearm vein. The incision is started at the left costal margin anteriorly and extends posteriorly over the course of the eighth rib, curving upwards a short distance between the spine and the left scapula. The eighth rib is resected, cutting its neck posteriorly and the cartilage anteriorly. It is usually necessary to divide one or more ribs posteriorly (often the seventh, sixth, and fifth) in order to provide access to a high growth and for the performance of a very high anastomosis. The wound edges are protected with large gauze pads, a rib-spreader is inserted, and the lung is retracted using a Harrington retractor over a protecting pad of gauze.

The resectability of the growth must be determined next. The mediastinal pleura is incised and the dissection is begun anterior to the esophagus, so as to free the attachments of the growth to the structures in the hilum of the lung. At this point, invasion of the left main bronchus, extensive involvement of the region around the inferior pulmonary vein, or fixation to the aortic arch may make it impossible to remove the tumor. If the adhesions to these structures can be divided safely, the dissection of the posterior attachments is then begun. This step in the procedure is left until last so as to avoid interference with the blood supply to the midesophagus which would result from dividing one or more of the esophageal arteries which arise from the aorta. Extensive fixation to the aorta or actual invasion of its wall makes it necessary to abandon the operation in some cases. After the posterior attachments are divided, the growth must be freed from the right mediastinal pleural reflexion. In many cases it is necessary to excise a portion of this pleural layer, thus, leaving a wide opening into the right thoracic cavity. The anesthetist's closed system makes it possible to prevent collapse of the right lung by exerting positive pressure and no attempt need be made to close the right pleural cavity. In the majority of such cases the defect is too large to be closed and after the left lung has been expanded and the chest closed, no ill effects have been observed as a result of leaving it open. It was necessary to open the right pleural cavity in 13 of the 32 cases reported. No complications which could be attributed to this occurrence were observed. In a few cases small portions of the adjacent lower lobe of the right lung have been removed because of fixation to the growth at that point. The defect in the surface of the lung is closed with a running suture of fine No. 00 catgut on an atraumatic needle.

After the esophagus has been dissected free from the level of the aortic arch downwards to its fullest extent, the abdomen is entered by incising the diaphragm from the insertion at the costal margin through the esophageal hiatus. The phrenic nerve is crushed to maintain immobility of the diaphragm. The numerous branches of the phrenic artery which are severed in the making of this incision are then tied with suture ligatures. The upper two-thirds or more of the stomach are then freed in order to make it possible to move the fundus to a high level within the chest for the anastomosis. The gastrolenal ligament is divided and the left gastro-epiploic vessels and the vasa brevia are cut and tied. The spleen is protected with gauze and retracted. The gastrocolic omentum is divided as far as the pylorus, taking care to avoid injury to the right gastro-epiploic vessels. The attachments of the cardia and lower esophagus are then cut, including several small vessels which are branches of the superior suprarenal, inferior phrenic, and pericardiophrenic vessels. The gastrohepatic ligament is cut next. Occasionally an artery of appreciable size is encountered in this structure. This vessel is an hepatic branch of the right inferior phrenic artery. Finally, the left gastric vessels are cut and tied close to the origin of the artery from the celiac axis. After this vessel has been severed, the fundus of the stomach can be placed without difficulty in the apex of the chest (Fig. 1, insert).

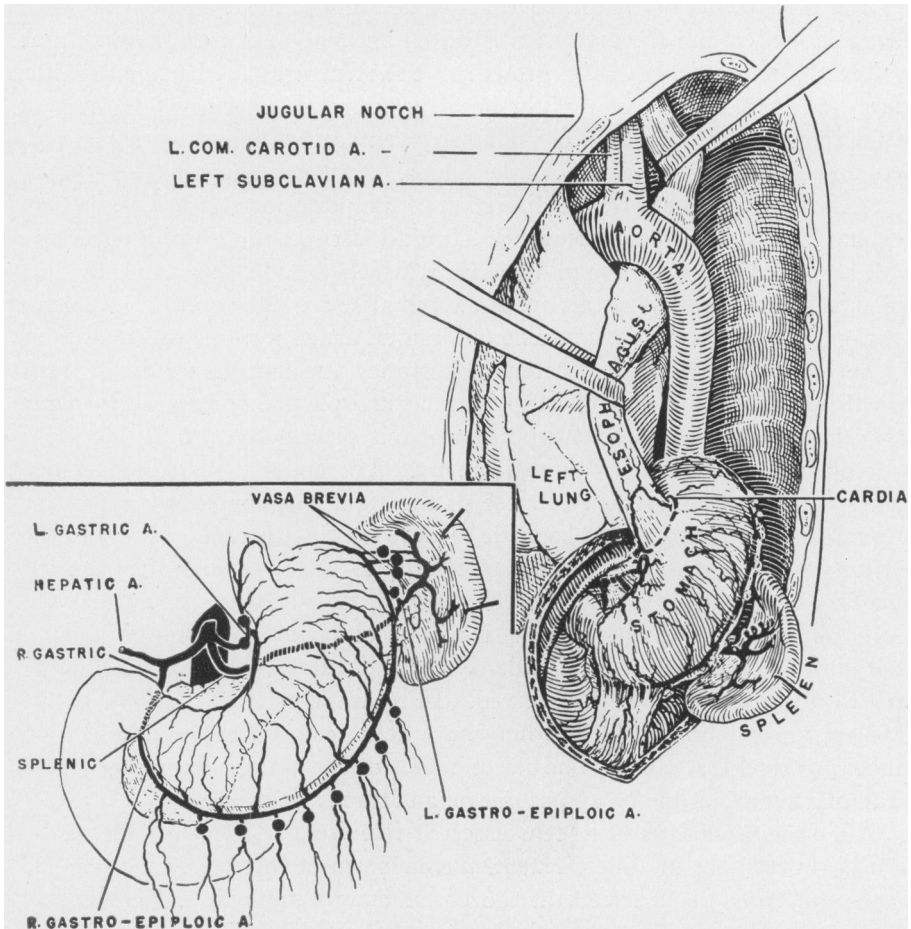


FIG. 1.—Dissection required for esophagectomy and high supra-aortic intrathoracic esophagogastric anastomosis. Complete mobilization of the esophagus to the apex of the chest. Mobilization of the stomach leaving only the right gastric and gastro-epiploic arteries. Inset: Large dots show the blood vessels which must be severed.

The stomach is now divided between clamps just distal to the cardia in such a way as to make it possible to remove the lymph nodes located around the lower esophagus and cardia and those in relation to the left gastric vessels. The distal portion is inverted by means of two layers of continuous sutures of fine chromic catgut reinforced with a layer of interrupted silk sutures. A rubber glove is tied over the lower end of the esophagus.

After the mobilization of the stomach has been completed, an incision is made in the mediastinal pleura above the aortic arch. The portion of the esophagus which lies in the superior mediastinum is now freed by blunt dissection and a piece of Penrose drain is passed around it for traction. By dissection, now from above, now from below, the attachments of the esophagus behind the aortic arch are freed. At this point, several small arteries, some

of which arise from the aorta and some from the bronchial arteries, must be divided. These constitute the last of the esophageal blood supply which arises from within the chest itself. If the growth is very adherent behind the aortic arch, greater exposure may be obtained by cutting the upper one or two left intercostal arteries. The aortic arch may then be retracted forwards sufficiently to complete the dissection behind it. The thoracic duct may be encountered behind or just above the aortic arch at this level. It should be carefully sought for and tied if injured or if it is necessary to resect a portion which may be adherent to the tumor. After the esophagus has been freed in this way, it may be pulled up from behind the aortic arch and turned outwards in a position convenient for the performance of the anastomosis (Fig. 2).

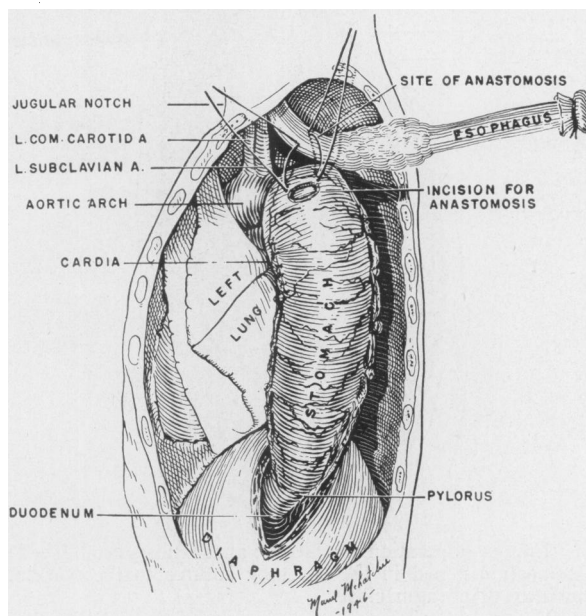


FIG. 2.—Stomach and esophagus completely mobilized and in position for the performance of anastomosis above the aortic arch.

In some cases where the upper limits of the tumor do not extend quite as high as the inferior margin of the aortic arch, dissection behind and above the arch is avoided and the anastomosis is performed just below the arch.

At a high level on the fundus of the stomach a circular incision of appropriate size is made through the serosal and muscular coats. The small vessels which cross this incision in the submucosal layer are tied with suture ligatures of fine silk in order to diminish the amount of bleeding during the performance of the anastomosis. A suitable site for the anastomosis is then chosen several centimeters above the upper limits of the growth, and an outer layer of mattress sutures comprising the first layer of the posterior half of the anastomosis is placed and tied (Fig. 2). A Wertheim clamp is then

put on the esophagus several centimeters distal to the site of anastomosis and with a right-angle knife blade (Beaver blade No. 14) the muscularis of the posterior esophageal wall is incised. The resulting muscle edge of esophagus is then sutured to the muscle edge of the stomach. The posterior half of the esophageal mucosa is then incised and the circular portion of stomach outlined by the initial incision through the serosa and muscularis is excised. The gastric contents are aspirated. The posterior mucosal layer of sutures is then

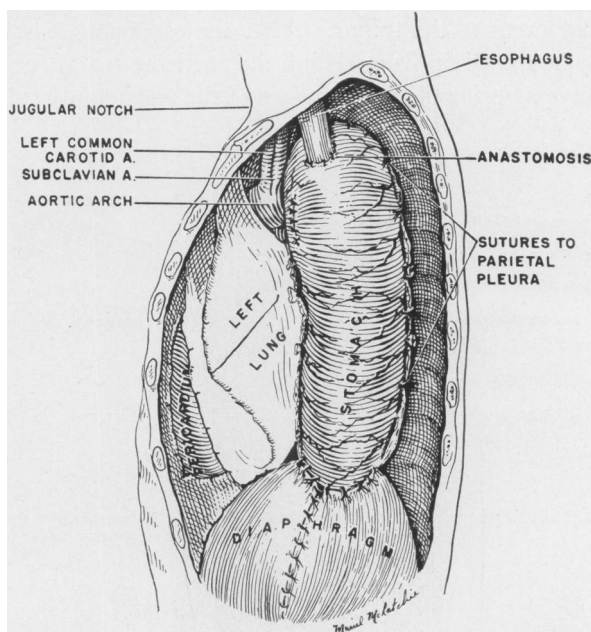


FIG. 3.—Operation completed; anastomosis established; stomach fastened in the chest by sutures to the parietal pleura; diaphragm closed.

applied. With a pair of scissors having bent blades the anterior wall of the esophagus is cut across and the segment to be excised is removed. The anterior aspect of the anastomosis is then completed with three layers of sutures. Fine silk is used throughout. A series of interrupted sutures is used to fasten the stomach to the parietal pleura so as to relieve the pull upon the anastomosis. The edges of the diaphragm are then fastened to the antral portion of the stomach where it passes through and the remainder of the edges of the diaphragm are approximated (Fig. 3).

A solution of penicillin containing 50,000 units is injected partly above and partly below the diaphragm before its closure is complete. A catheter for closed suction drainage is brought out through a short incision in a lower interspace posteriorly and the wound is closed by a careful anatomic approximation of its layers using interrupted silk sutures. The lung is fully expanded before closure of the chest is completely air-tight.

CARCINOMA OF MIDTHORACIC ESOPHAGUS

IMPORTANT DETAILS OF TECHNIC

(1) *Immobilization of the Stomach:* The extensive dissection described, including division of the gastrocolic, gastrolial, and gastrohepatic ligaments, the left gastro-epiploic, and the left gastric arteries and vasa brevia, is required in all cases where the high level of the tumor makes it necessary to place the fundus of the stomach above the level of the aortic arch. A further reason for cutting the left gastric artery at its origin from the celiac axis is the necessity for removing all the lymph nodes which are grouped about the ascending branches of this vessel.

TOTAL EXPERIENCE
CARCINOMA MIDTHORACIC ESOPHAGUS
1944 and 1945

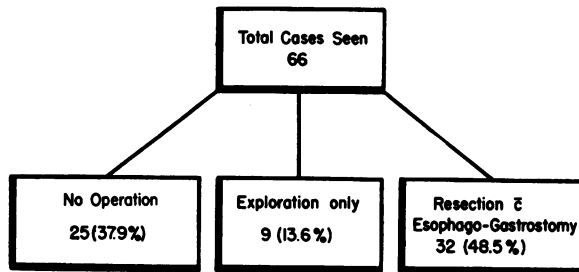


CHART I

(2) *Preservation of the Blood Supply:* (A) At the completion of the operation the stomach is dependent for its blood supply upon the flow from the right gastric and right gastro-epiploic arteries. The nutrition of the tissues at the site of the anastomosis high in the apex of the fundus depends primarily upon the preservation of a continuous arcade of vessels through the gastro-epiploics on the greater curvature side and the anastomoses between the branches of the right and left gastric arteries on the lesser curvature side. Of utmost importance, likewise, is the maintenance of the integrity of the intercommunicating vessels within the wall of the stomach which connect these two primary sources of supply. It is these vessels upon which the viability of the gastric wall at the site of the anastomosis is completely dependent. It is necessary, therefore, in handling the stomach throughout the entire operation to exert every effort to avoid trauma to its wall and to the vessels which course within it. A tear produced by a forcep or a clamp or an hematoma resulting from careless handling might be the determining factor in the occurrence of an unfavorable outcome.

(B) Preservation of an adequate blood supply to the site of anastomosis on the esophageal side depends upon a knowledge of the segmental nature of its blood supply. If the anastomosis can be made just below the aortic arch,

the integrity of the small arteries arising from the arch and from the bronchial arteries insures adequate nutrition of the tissues at the cut-end of the esophagus. If, however, it becomes necessary because of the high extent of the tumor to dissect the esophagus further and to pull it up from behind the aortic arch, the benefit of these vessels is sacrificed and the only remaining blood supply to the esophagus is that which descends from the inferior thyroid artery. It follows, therefore, that when the esophagus has been pulled out from behind the aortic arch it must always be divided at a high level within the chest in order to avoid necrosis of its cut-end at the anastomosis site. This must be kept in mind when there appears to be a relatively long, uninvolved portion above the tumor after the dissection has been carried out. Although it is more difficult from a technical standpoint to divide the esophagus high under these conditions, it may mean the difference between success and failure in the outcome of the operation.

(3) *Management of the Thoracic Duct*: If, as in the majority of cases, it is necessary to carry the dissection above the aortic arch, the thoracic duct may be encountered where it crosses the esophagus to assume a more anterior position behind the subclavian artery. If the growth lies in this region, the duct may be adherent to it or actually invaded, making it necessary to excise a segment. In some cases, after the esophagus has been dissected out, the thoracic duct may be seen loosely draped across the empty space left in the superior mediastinum. Under such conditions there is danger that the thinned-out or actually traumatized wall of the duct will result in leakage of chyle. In either case, it is important to tie the thoracic duct to prevent such an occurrence.

In the 32 cases reported, the thoracic duct was tied and divided in three, with no ill effects. In a fourth case, the duct was injured but through an oversight it was not tied. This patient died subsequently as the result of a persistent chylous hydrothorax.

(4) *Avoidance of Stricture at the Anastomosis*: Prompt and accurate healing of the layers of the anastomosis, especially the mucosa, is necessary to avoid extensive cicatrization and the resultant stenosis which follows the contraction of scar tissue. To accomplish this, all unnecessary trauma to the edges used in the anastomosis must be avoided. Measures which should be adopted to minimize the amount of trauma to these edges are (a) avoidance of the use of crushing clamps on either the gastric or esophageal side; (b) the utilization of knife and scissors to cut the esophagus and stomach instead of the cautery or a chemical caustic, such as carbolic acid on a knife; and (c) the use of interrupted fine sutures instead of running sutures which tend to constrict uniformly the edges of the entire circumference of the anastomosis and, thus, produce necrosis which results in delayed healing. The utilization of a circular opening in the stomach wall for the anastomosis may be of some further importance.

EXPERIENCE WITH CARCINOMA OF THE MIDTHORACIC ESOPHAGUS IN 66 CASES
SEEN DURING 1944 AND 1945

The first resection and high intrathoracic esophagogastric anastomosis above the aortic arch for carcinoma of the midthoracic esophagus at the Massachusetts General Hospital was performed early in 1944. Since then, this procedure has been used in these cases in place of the Torek operation.

Operability: During 1944 and 1945, 66 cases of carcinoma of the middle half of the esophagus were observed (Table III). Of these, 25 were considered to be inoperable because of their extremely poor general condition.

TABLE III
CARCINOMA OF THE MIDTHORACIC ESOPHAGUS
Operability—1944 and 1945

	No.	Per Cent
Total cases seen.....	66	
Cases operated upon.....	41	62.1
Resection performed.....	32	48.5
Total cases operated upon.....	41	
Exploration only.....	9	22.0
Resection with anastomosis.....	32	78.0

The majority of these died within a few weeks of the time they were first seen at this hospital. Forty-one patients, however, were operated upon after adequate, often prolonged preoperative preparation to improve their nutritional status. Of this number, nine were found to have tumors which could not be removed. In the remaining 32 cases a radical resection followed by high intrathoracic esophagogastric anastomosis was performed. Thus, of the total number of patients seen 62 per cent were operated upon, and it was possible to perform a radical operation in 48.5 per cent. Of the total number of patients operated upon, 78 per cent were given the benefit of resection (Table III). This high resectability is the result of a policy in the management of these cases which is calculated to provide a worth while degree of palliation for as many patients as possible by always removing the growth unless there is a serious technical obstacle which prevents it.

Inoperable Cases Explored: In nine cases it was impossible to remove the growth because of extensive local fixation and invasion of important structures, such as the aorta, the bronchus, or the inferior pulmonary vein. Eight of these patients made an uncomplicated recovery following the exploratory thoracotomy and left the hospital. One died of widespread lymphatic invasion of both lungs while still in the hospital. The majority of the remaining patients died within a few months after exploration.

Cases of Resection Followed by Anastomosis.—Age of Patients: Before taking up the consideration of the results of resection, it is important to bear in mind that a very large percentage of the patients upon whom a resection and high anastomosis was performed were old. Table IV illustrates the age distribution. It is noteworthy that over one-half of the patients (19 in all) were 65 years of age or older. Five of these were 70 or more.

OPERATIVE EXPERIENCE
CARCINOMA MIDTHORACIC ESOPHAGUS
1944 and 1945

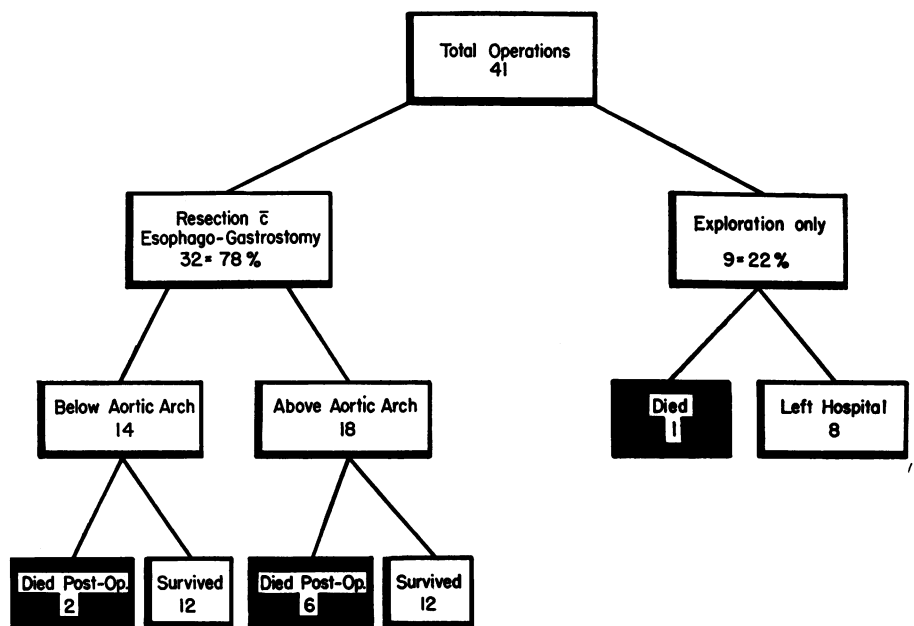


Chart 2.

Distribution According to the Level of Anastomosis: Of the 32 patients who had an esophagectomy carried out, it was possible to perform the anastomosis just below the aortic arch in 14. But in the remaining 18 cases it was necessary to dissect the esophagus from behind the aortic arch and perform the anastomosis above the arch (Chart 2). The importance of this is reflected in an analysis of the frequency of complications and postoperative deaths.

TABLE IV

AGE DISTRIBUTION OF RESECTION CASES

40-45.....	1
45-50.....	2
50-55.....	2
55-60.....	3
60-65.....	5
65-70.....	14
70, or over.....	5

For example, of the 13 cases in which complications developed, ten were in the group where the anastomosis was performed above the aortic arch and only three were in the group where the anastomosis was carried out just below the arch. Likewise, the number of postoperative deaths was much larger in

CARCINOMA OF MIDTHORACIC ESOPHAGUS

TABLE V

CARCINOMA OF THE MIDTHORACIC ESOPHAGUS (32 CASES)

Complications Following Resection with High Esophagogastric Anastomosis

Complication	Subaortic Anastomosis	Supra-aortic Anastomosis	Total
Cardiac Disorders:			
Congestive failure.....	0	4	4
Myocardial infarction.....	1	0	1
	<hr/>	<hr/>	<hr/>
	1	4	5
Manifestations of Infection:			
Wound sepsis.....	0	1	1
Empyema.....	0	1	1
Mediastinitis.....	0	1	1
	<hr/>	<hr/>	<hr/>
	0	3	3
Chylous hydrothorax.....	0	2	2
Pulmonary embolus (sublethal).....	1	0	1
Pulmonary atelectasis.....	1	0	1
Surgical shock.....	0	1	1
	<hr/>	<hr/>	<hr/>
Total.....	3	10	13

the former group than in the latter (six cases as compared with two cases). The explanation of these observations lies in an appreciation of the fact that the higher the lesion is, the greater the amount of dissection required and the more the trauma which results. The supra-aortic anastomosis group, in addition to the hazards of a larger amount of dissection in the mediastinum close to the heart and other vital structures there, is subjected to a longer procedure and to the hazards of a more difficult anastomosis.

Analysis of the Complications and Causes of Death Occurring after Resection: Tables IV and V enumerate the complications and causes of death which

TABLE VI

CARCINOMA OF THE MIDTHORACIC ESOPHAGUS (32 CASES)

Causes of Death Following Resection with High Esophagogastric Anastomosis

Cause	Subaortic Anastomosis	Supra-aortic Anastomosis	Total
Cardiac Disorders:			
Congestive failure.....	0	3	3
Myocardial infarction.....	1	0	1
	<hr/>	<hr/>	<hr/>
	1	3	4
Sepsis:			
Empyema.....	0	1	1
Mediastinitis.....	0	1	1
	<hr/>	<hr/>	<hr/>
	0	2	2
Chylous hydrothorax.....	0	1	1
Pulmonary atelectasis.....	1	0	1
	<hr/>	<hr/>	<hr/>
Total.....	2	6	8 (25%)

developed in the group of 32 patients who were subjected to resection and high intrathoracic esophagogastric anastomosis.

Cardiac Disorders: As might be expected, the greatest incidence of cardiac disorders was in the group of patients who had a supra-aortic arch anastomosis. Four of this group developed congestive failure and three of these died. Myocardial infarction developed in one patient of the subaortic anastomosis group. This patient died.

Manifestations of Infection: Only three patients of the entire series developed sepsis. In all three cases the difficulty arose in the group of patients

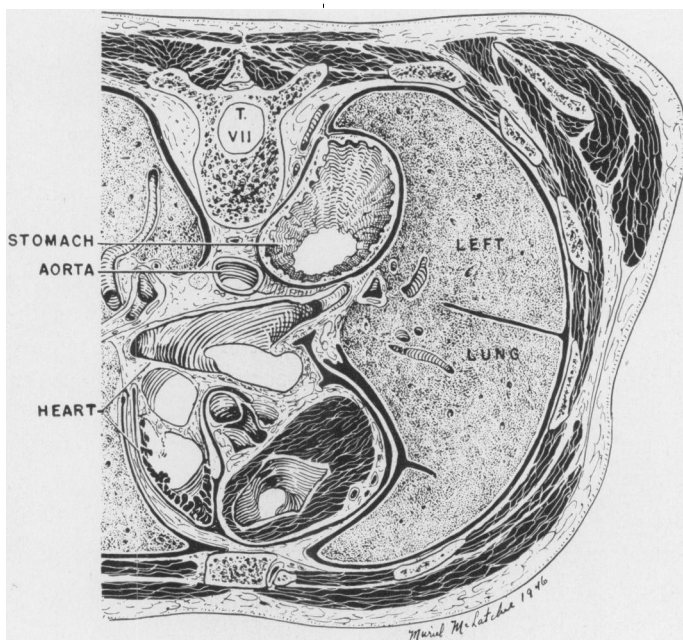


FIG. 4.—Cross-sectional relations of viscera at level of thoracic vertebra VII, showing stomach behind the hilum of the lung.

who were operated upon in 1944, before penicillin was available for civilian use. Since penicillin has been used routinely as a prophylactic measure, there have been no manifestations of infection of any kind in 29 consecutive cases. *Major wound sepsis* occurred in one case. The organism was *Staphylococcus aureus*. A special grant of penicillin was obtained, as a result of which the infection was brought under control. *Empyema* developed in one case. Penicillin could not be obtained. Drainage was established by rib resection but the patient, who was elderly and in poor general condition, died. The third case of infection was a severe and ultimately fatal *mediastinitis* resulting from accidental perforation of the growth during the process of dissection behind the aortic arch in a case which was practically inoperable.

Chylous hydrothorax developed in two cases. Both occurred in the right side of the chest. In each case a portion of the right mediastinal pleural reflexion had been removed. In one, the accumulation was gradual and never very large in amount. It developed several weeks after the operation and was probably the result of involvement of the thoracic duct by carcinoma arising in lymph node metastases within the mediastinum. The patient left the hospital and died a few months later of metastatic disease. This case appears in Table IV but not in Table V. In the other case the chylous effusion developed during the first few days after the operation and resulted in the death of the patient. It was in this case that the injury to the thoracic duct was observed at operation, but through an oversight the duct was not tied. In both these cases a supra-aortic anastomosis was performed.

A *sublethal pulmonary embolus* occurred in one patient. Immediate bilateral superficial femoral vein ligation was resorted to, and no subsequent emboli developed. The patient recovered and has had no difficulty with his legs since the ligation was performed.

Pulmonary atelectasis developed on the left side in one elderly woman who had an emphysematous chest with a marked kyphosis. Bronchoscopic aspiration failed to produce permanent relief and the patient died on her 4th post-operative day.

Transitory surgical shock occurred in one patient. It responded to the usual methods of treatment.

SUMMARY

The inadequacy of the Torek procedure from the standpoint both of cancer cure and of palliation in unfavorable cases has made it necessary to abandon the procedure after a trial of 14 cases.

Recent experience has demonstrated the superiority, in each respect, of resection followed by a high intrathoracic esophagogastric anastomosis placed either just below or actually above the aortic arch. This technic is applicable in any case when the growth is located in the middle half of the esophagus, even in cases where the tumor extends upwards behind the arch.

A report of experience in the use of this procedure in 32 cases of carcinoma of the midthoracic portion of the esophagus is given. The technic of the procedure and the complications and causes of death are discussed.

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- ¹ Torek, F.: The First Successful Resection of the Thoracic Portion of the Esophagus. *J. A. M. A.*, **60**, 1533, 1913.
- ² Sweet, R. H.: Surgical Management of Carcinoma of the Midthoracic Esophagus: Preliminary Report. *N. E. J. Med.*, **233**, 1, 1945.

DISCUSSION.—DR. HAROLD W. WOOKEY, Toronto, Ont.: I have been very much interested in Doctor Sweet's paper on the treatment of cancer of the midthoracic esophagus. A good many of us have operated upon such cases using some modification of the original Torek procedure, but there is no question that patients who try to exist with an esophageal fistula and a gastrostomy are in a most unhappy state. Conse-