

## TREATMENT OF ATRESIA OF THE ESOPHAGUS BY THE TRANSPLEURAL APPROACH

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**T**HE problem of esophageal atresia with or without tracheoesophageal fistula has been a difficult one to handle for many years. The first case of successful management was recorded in medical literature by Ladd only a decade ago. Sixty-one cases have been seen at the Children's Hospital of Philadelphia since 1947 and it was thought that a review of the cases was indicated, especially since we believe that there have been advances made following the institution of a routine transpleural operative approach in 1950. Prior to that year, the classical, retropleural procedure had been used and the results were so discouraging that it was decided to operate transpleurally. This report records the experience of the authors with both retropleural and transpleural procedures during the period 1947 through 1952.

### HISTORICAL BACKGROUND

Before 1929, the operative correction of this lesion consisted of a gastrostomy. The mortality remained 100 per cent, due to aspiration pneumonia. Some then tried to re-establish esophageal continuity by a multiple stage procedure in which the fistula was closed and the proximal blind stump brought out in the neck—all by extrapleural technique. A gastrostomy was combined with this, and subsequent stages consisted of fashioning antethoracic skin tubes to connect the cervical esophagus and the stomach. The discouragement and failure of these attempts were recorded by Lanman in 1940. However, in the course of such experiences several primary end-to-end anastomoses were attempted, and, while unsuccessful, they pointed the way to the desirability of this method. Ladd and Leven almost simultaneously performed the first successful

multiple stage operations on the tracheoesophageal problem in 1939. However, it remained for Haight (3) in 1941 to fulfill the expectations of many that a successful end-to-end anastomosis would eventually be accomplished. Since then, the majority of operators in the field have been using this way of handling the anomaly, reserving the ingenious methods of Sweet, Longmire, and Potts for those fortunately few cases in which the distance between proximal and distal esophageal segments is too great for primary anastomosis. Almost uniformly the incisional approach to the primary union has been posterior and extrapleural.

### CLINICAL PICTURE

The clinical picture of esophageal atresia has been well described by other authors. The diagnosis of atresia of the esophagus, with or without tracheoesophageal fistula, should be suspected when a baby is born cyanotic and, after the aspiration of viscid mucus from his nasopharynx, becomes cyanotic again with the reaccumulation of nasopharyngeal secretions. The diagnosis should not be delayed after the first feeding when with the second swallow the feeding is forcibly ejected through the nose and mouth. Unfortunately, most diagnoses are delayed beyond this time and aspiration pneumonia, which is one of the major complications of this anomaly, becomes well established.

The diagnosis of atresia of the esophagus can be confirmed by the passing of a soft rubber catheter through the nose into the upper esophagus. When atresia exists, an obstruction will be met just below the clavicle, approximately 9 to 11 centimeters from the nose. Roentgenograms may be taken for visual confirmatory evidence, with or without a contrast medium. We prefer to use no medium, but certainly a radiopaque oil is prefer-

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TABLE I.—MORTALITY STATISTICS

	Living	Dead	Mortality Per cent
Ladd	11	23	68
Boston Children's (2)	100	115	51
Haight (4)	41	45	52
Potts	15	17	53
Arnheim	3	16	84
Leven	56	40	42
Koop and Kiesewetter	27	34	56

able to barium because of the probability of aspiration. Air in the gastrointestinal tract denotes the presence of a fistula between the lower esophagus and the tracheobronchial tree.

#### TECHNIQUE

The transpleural approach to esophageal atresias is not original with the authors. It has been used by others in occasional cases, and has been advocated in the literature by Singleton and later by Lyon. However, as far as can be ascertained, this is the first large group of patients treated by this method. We had confidence in starting a series because of the wide experience gained by our anesthetists with endotracheal anesthesia, during which remarkably few respiratory complications arose.

The infant, under endotracheal anesthesia, is placed in the left lateral decubitus position and an incision made from the costochondral junction back to the sacrospinalis muscle. The pleural cavity is entered through the third or fourth interspace, and adequate exposure is gained by using a self-retaining retractor without dividing any ribs. The lung is retracted to expose the azygous vein which is divided. A small No. 8 French catheter is then inserted via the nares into the esophagus by the anesthetist to facilitate identification of the upper pouch. The mediastinal pleura is opened and the upper portion of the esophagus is mobilized as far cephalad as possible for future anastomosis. The lower esophagus and fistula are then identified posterior to the trachea and medial to the prominent vagus nerve. Most fistulas enter the tracheobronchial tree near the carina or just below it in the right main bronchus. The dissection of

the lower esophagus must be gentle because it lacks both the blood supply and the muscular hypertrophy found in the proximal segment. The dissection of the lower esophagus has had to be carried down to the diaphragm in a few cases and has been followed by successful anastomosis. The separation of the esophagus from the trachea is done by placing a strip of rubber drain around the esophagus for traction, dividing the fistula and oversewing the tracheal side a short distance at a time with 5-0 silk. After completing the division of the fistula, a running stitch reinforces the first suture line. The closure is then tested under water for air leaks.

The esophageal anastomosis is a one layer closure of simple stitches using 5-0 silk. It is important to trim any ragged edges on the lower esophagus before carrying out the anastomosis. Four guide sutures are placed around the circumference of the lower segment for traction and exposure of the lumen. The upper segment must be opened at its most dependent portion, and it is usually wise to cut an actual section out of the atretic portion rather than to make a mere slit, in order to minimize the obstruction when the two disproportionate segments are anastomosed.

The mucosa must be caught with each stitch as the closure is carried out. With one-third of the circumference secure, the No. 8 French catheter lying in the proximal segment is passed through the anastomosis to facilitate the remaining two-thirds of the closure. As few as 9 stitches have been used although 12 is an average number. If the anastomosis is not under great tension and is tight, the mediastinal pleura is reapproximated and the chest closed without drainage. If the anastomosis has sufficient tension on it so that one would hesitate to feed across it early, a small diameter polyethylene tube with a rubber catheter tip is threaded down into the stomach under direct vision. If the presence of this tube in any way exerts pressure on the anastomosis, it is withdrawn and a gastrostomy is performed then or within 48 hours as a separate procedure under local anesthesia.

Postoperative care includes an atmosphere of high humidity, frequent nasopharyngeal aspirations of mucus, liberal use of antibiotics,

and parenteral fluids without salt in quantities less than used for most other neonatal conditions. The anesthetists do direct tracheal aspirations daily for several days as indicated, and either blood or plasma is given supportively each day.

Feedings by mouth, gastrostomy, or tube are begun on an average of 48 to 72 hours after operation, although some children have been fed as early as 24 hours postoperatively.

RESULTS

In the 6 year period, 1947 to 1952, sixty-three patients have been admitted to the Children's Hospital of Philadelphia with a diagnosis of esophageal atresia, with or without tracheoesophageal fistula. Sixty-one were operated upon (9 by resident house staff) and will comprise the material for this analysis. The remaining 2 died before surgery could be carried out. Wherever possible and desirable the results will be analyzed by breaking them down into two groups—those operated upon by the retropleural technique and those done by the transpleural technique.

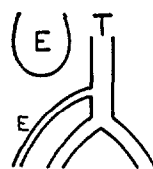
*Mortality.* When the retropleural technique was used, 14 of 19 patients died, a mortality of 73.7 per cent. Twenty of 42 patients operated upon transpleurally died, a mortality of 47.6 per cent. The overall mortality for the entire group was 55.7 per cent. There were no deaths on the operating table.

These figures are compared with other large series reported in Table I. If we had reported our first 15 transpleural cases we could have cited a mortality of only 26 per cent.

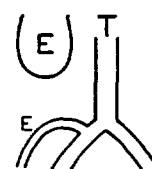
Mortality alone, in a defect such as atresia of the esophagus, is not the sole criterion of the worth of a given technique.

*Color.* There seems to be no sex predominance in this series of 31 females and 30 males, but it is of interest to record an apparent predilection for the white race. Although our admission ratio of white and colored patients is about 3 white for each colored child, only 2 cases here reported were in colored infants.

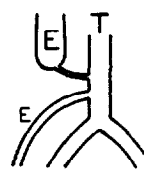
*Age at operation.* The age of the patient at the time of operation bears a definite relation-



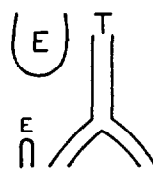
48 CASES  
(21 ALIVE)



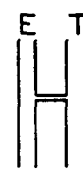
6 CASES  
(4 ALIVE)



1 CASE  
(DEAD)



4 CASES  
(ALL DEAD)



2 CASES  
(BOTH ALIVE)

Fig. 1. Anatomic types of atresia of the esophagus.

ship to his chances for survival, and is summarized as follows: Of the 41 infants operated upon before they were 72 hours old 22 survived, 19 died, a mortality of 46 per cent. Of the 20 operated upon after they were 72 hours old 5 survived, 15 died, a mortality of 75 per cent. Twenty-two of the 27 patients now alive (82 per cent) were operated upon before they were 72 hours old. The youngest survivor was 16 hours old and the oldest 9 days.

*Weight.* The mortality in this series is inversely proportional to the weight of the infant. The highest mortality is in the premature group; 17 of our patients were under 5 pounds, with a distressing mortality of 82 per cent. There were 42 over 5 pounds, with a mortality of 43 per cent. The admission weights of 2 were not recorded. The smallest infant was 3 pounds 2 ounces, and the largest was 7 pounds 5 ounces. The lightest survivor weighed 4 pounds 8 ounces, and the heaviest child now living was 7 pounds 4 ounces.

<sup>1</sup>Since this study was undertaken, 11 additional cases have been operated on transpleurally with 7 survivals. This would make the mortality in all the transpleural cases 45.4 per cent.

*X-ray examination.* An attempt was made to determine whether the use of radiopaque material in the diagnosis of this condition played any appreciable part in the mortality. In 30 cases it was used and in 31 it was not. The mortality in the two groups was essentially the same.

All patients who had preoperative films were analyzed with respect to the influence of preoperative pneumonia or atelectasis on mortality. Thirty-one cases were diagnosed by roentgenologists as having pneumonia or atelectasis. The mortality in these patients was essentially the same as in those with roentgenologically clear lung fields.

*Anatomic types* (Fig. 1). Forty-eight patients had the common anomaly of atresia of the esophagus with a fistula between the distal esophagus and the trachea. Twenty-one of these are now alive. Six infants had atresia with a fistula connecting the distal esophagus and the right main bronchus; 4 of them survived. In only 1 patient was there a fistula between the proximal esophagus and the trachea. This infant had massive pulmonary atelectasis probably on the basis of amniotic aspiration in utero, and it died. Two patients had a fistula without atresia and are alive. Four infants had atresia without fistulas and all are dead; 3 of these had no distal esophagus.

*Associated congenital anomalies.* Major congenital defects were noted in 16 of the 61 patients. In several patients the lesions were multiple, there being 22 anomalies in 16 patients: congenital heart disease in 6 cases, atresia of bile ducts in 1, abnormalities of urinary tract in 4, mongolism in 2, harelip and cleft palate in 1, imperforate anus in 3, absence of arm in 1, reduplication of esophagus in 1, bowel atresia in 1, absence of tracheal ring in 1, and omphalomesenteric cyst in 1 case. Minor defects, such as hemangiomas, are not considered.

In addition to these associated anomalies, 3 patients had complications in their management. One had a severe erythroblastosis and 2, who did not survive, had pyloric stenosis. The clinical course of the latter 2 did not suggest the diagnosis even in retrospect.

Several of the associated lesions were in themselves incompatible with life. It is our

belief that 5 patients in the retropleural group and 3 in the transpleural series would have survived had they not had these severe multiple anomalies.

*Operative procedures.* In the 57 cases in which there was a distal esophagus, an attempt was made to do a primary end-to-end anastomosis after closure of the fistula. This was accomplished in all but 1 case in which a cervical esophagostomy was carried out after closing the fistula and the distal esophagus. This child awaits definitive surgery.

In the group of 19 patients who were operated upon by the retropleural approach, 6 had gastrostomies for feeding purposes and 2 for retrograde esophageal dilatations. In the transpleural group of 42 patients, 6 gastrostomies were done for feedings, 2 for dilatations. A polyethylene tube was employed 9 times across the anastomosis in the transpleural group.

The operating time in the transpleural group was considerably reduced, which we believe is of significance in the mortality. The average retropleural operating time was 2 hours and 4 minutes, while in the transpleural group the average time was 1 hour and 40 minutes. The shortest "skin to skin" operation in the transpleural group was 45 minutes, and 4 operations were performed in less than an hour.

*Complications.* Serious complications encountered in the surgery of esophageal atresia have been of three types:

1. Respiratory obstruction.—In our experience no infant patients have more aberrations in respiratory physiology than do those with postoperative atresia of the esophagus. Constant nursing care, frequent mucus aspirations, and a house staff prepared to meet emergencies overcome most of the difficulties.

In this series, tracheotomies were done 4 times, none we believe because of endotracheal anesthesia. One infant in the retropleural group had no tracheal rings; this child lived. In the transpleural group 3 tracheotomies were necessary. Two were performed to obtain adequate airways; in 1 of these cases bronchoscopy had been done elsewhere before admission. One tracheotomy was carried out 40 days postoperatively for a tracheobronchial

infection. This case was the only death among the tracheotomies.

2. Esophageal stenosis.—Six patients required dilatation of the anastomosis, 2 in the retropleural and 4 in the transpleural group. Of the 6, 4 had gastrostomies for retrograde bouginage. All are alive and well.

3. Leaking anastomoses.—Six anastomoses leaked, 1 of which was in the retropleural group. The 5 patients in the transpleural group were operated upon a second time without success.

Air leaks at the site of fistula closure have not been experienced, and only 1 closure has compromised the lumen of the trachea and produced symptoms.

*Follow-up.* Follow-up data are available on 23 of the 27 surviving members of our series, brought up to date as of February 1, 1953 by personal examination or mail report. Of the 23 followed, 20 are asymptomatic and developing normally. One still has a tracheotomy at the age of 1 year, 1 has a gastrostomy and is undergoing esophageal dilatations, and 1 has a cervical esophagostomy and gastrostomy and will need further definitive surgery.

#### DISCUSSION

Early diagnosis is of paramount importance in the successful management of this and other surgical lesions of the newborn. In 82 per cent of our patients now alive, diagnosis was made and operation performed before they were 72 hours old. Only 38 cases of the whole group were diagnosed before the infant was 72 hours of age, which gives a survival among the early cases of 58 per cent. By contrast, only 5 of the remaining 23 patients are alive, giving a survival of only 22 per cent, when diagnosis of the lesion was delayed beyond the first 3 days of life.

It is apparent that esophageal atresia is more prevalent in premature and small babies. Which is cause and which is effect cannot be accurately assessed, but 90 per cent of the patients in this series were below 7 pounds. Thirty-eight per cent of cases occurred in premature infants (under  $5\frac{1}{2}$  pounds).

The greatest therapeutic challenge was presented by the 4 patients with no distal esophagus, or a segment not long enough to anasto-

mose to the proximal pouch. Three of these had other anomalies or situations which could be considered incompatible with life so that the mortality is a reflection of more than the lesion under discussion.

The use of the transpleural approach to atresia of the esophagus was not the only change in managing these patients as compared with the retropleural route. Fewer sutures were used in the anastomosis, gastrostomies were avoided where possible, and feedings were begun by mouth as early as seemed safe. This combination seemed to prevent the narrowing of the esophageal lumen at the site of the anastomosis, and postoperative dilatations were not troublesome.

Diagnosis of a tracheoesophageal fistula without an accompanying atresia is difficult. One of the 2 reported here was seen by the bronchoscopist on the third attempt at visualization after repeated noncontributory lipiodol studies. The other was found by the simple method of withdrawing a No. 10 French catheter from the stomach while listening at the open (proximal) end. As the fistula was passed, the respiratory sounds could be heard from the open end of the catheter.

It would seem that after some experience with infants with esophageal atresia one can almost predict the failures and successes on the basis of age, weight, associated anomalies, and that immeasurable something that is tied up in what we call a "good baby." For example, there are some babies of satisfactory age and weight who have no additional demonstrable anatomic defects, but whose respirations are never properly established and whose ability to suck and swallow seems to be diminished. Other infants who appear to be good risks have such friable tissues as to preclude satisfactory anastomosis. These factors may be absent in a small series. In a large one, they combine to give a true picture of the barriers to success which the surgeon faces in a congenital anomaly incompatible with life yet theoretically susceptible to surgical correction. For these reasons, the examinations of statistics alone may not give a true indication of the difficulties presented by the anomaly or the advantages of a given technique.

We believe that transpleural approach to atresia of the esophagus, followed by direct feedings by mouth or via a polyethylene tube instead of a gastrostomy, has much to recommend it. This is true not only for the pediatric surgeon or thoracic surgeon, but perhaps more so for the occasional operator in this field. Operating time, always a factor in the care of infants, is greatly reduced. The exposure is excellent, and the number of surgical procedures is reduced. We do not believe that any of the difficulties we have encountered in the transpleural approach would have been less hard to surmount by the usual retropleural method.

#### SUMMARY

A series of 61 cases of esophageal atresia has been reviewed and analyzed.

Forty-two patients were operated upon by the transpleural approach with a mortality of 47.6 per cent.

The advantages of the transpleural compared with the retropleural method include: better exposure, a shorter operating time, and fewer operative procedures.

A single layer anastomosis of few sutures with early feedings by mouth seem to be associated with fewer strictures at the site of anastomosis.

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