THORACIC DIVERTICULA WHICH ORIGINATE FROM THE INTESTINE*

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THERE HAVE COME to our attention three cases of unusual nature, in each of which a hollow structure within the chest proved to be an elongated diverticulum which came through the diaphragm and which was found to have an origin from the small intestine. In spite of a wide experience with congenital malformations, we have not previously encountered such an anomaly, nor have we found descriptions of it in the literature. We are therefore prompted to publish a note regarding the symptomatology and the surgical treatment of these patients.

In each of these cases there arose from the duodenum or from the jejunum a side-arm which left the intestine at a right-angle and coursed upward to the right crus of the diaphragm, which it pierced. Parts of such a side-arm had the general diameter, thickness and appearance of a loop of the patient's intestine, but in some places it ballooned out into quite a voluminous structure. As it ran superiorly to reach the diaphragm, the diverticulum always had a deep-lying position behind the stomach or behind the gastrohepatic ligament. In two cases, a diverticulum in the jejunal mesentery was close to branches of the superior mesenteric vessels, and then passed anterior to the pancreas. In the third case, a diverticulum (from the first part of the duodenum) ran upward and slightly backward to reach an area behind the vena cava.

All three of these diverticula penetrated the right side of the diaphragm and thereafter continued upward in an extra-pleural location in the posterior part of the chest. While they projected into and encroached upon the pleural cavities, they were always covered by parietal pleura. Above the diaphragm, the diverticula assumed multiple forms; either they remained as a narrow, tubelike structure or else they widened out into a more capacious and rounded mass. The intra-thoracic extent of these anomalies was a remarkable feature, for in all instances they rose to the very apex of the chest. In our first case, the diverticulum was long enough to be coiled upon itself, lying just above the diaphragm and to the right of the heart. The structure then coursed upward, took a sharp angulation to the left, ran behind the esophagus and the aorta, turned upward and proceeded to the left apex of the thorax. In our next case, the diverticulum was about the diameter of intestine as it came up through the diaphragm, but then quickly expanded into a more globular form,

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the central part of which was compressed by the azygos vein, giving it a dumbbell shape. This hollow mass extended to the right thoracic apex and had a volume which was more than half that of the right pleural cavity. In our third patient, the diverticulum in the lower third of the chest had the diameter of intestine, its middle third had a bulbous enlargement, while the upper third diminished again to a tube about twice the size of intestine.

The blood supply of these diverticula, while coming partly from the mesentery of the jejunum or from the duodenum, did not all arise from such sources. It was obvious that numerous arteries and veins joined them from the diaphragm and from many parts of the mediastinum.

The sizes of the diaphragmatic defects were of some interest. In our first case, the opening was large enough to permit herniation of several loops of ileum up into the chest (alongside of the diverticulum). In the other two cases, the diverticula pierced the diaphragm through a small opening, the edges of which were firmly adherent to the diverticular walls.

These diverticula had smooth muscle coats and were lined by mucosa resembling some portion of the alimentary tract. In our first case the lining was similar to that of jejunum, colon and the respiratory tract, while in the other two it resembled gastric mucosa, it being found to secrete hydrochloric acid and pepsin.

The symptomatology in these patients was referable to: (1) The accumulation of gas or material within the thoracic portion of the diverticulum in such a way that it gave cardio-respiratory disturbances. (2) The formation of hydrochloric acid and pepsin within the diverticulum, which produced ulceration in the neck of the diverticulum or nearby intestine, so that serious hemorrhage ensued from the alimentary tract. (3) The accumulation of very acid material within the diverticulum, which produced an intense reaction in its wall and in regional structures, so that chest pain appeared. In our first subject, a child of three months, there had been bouts of dyspnea, cyanosis and vomiting, which were presumably induced by the backing up of intestinal material and gas into the long arm in the chest in a way that led to pressure on important intra-thoracic viscera. In our second patient, the huge diverticulum must have produced enormous amounts of gastric juice (the pH of which was shown to be 3.9); the discharge of this unneutralized fluid into the jejunum led to intestinal ulceration and exsanguinating hemorrhage. In our third patient, the primary complaints were related to pain in the chest, which was particularly aggravated during deglutition. This pouch was lined by gastric mucosa and was filled with a fluid containing hydrochloric acid and pepsin. This activated material had set up an intense reaction throughout the wall of the upper half of the diverticulum, which reaction had extended into regional tissues and into the para-esophageal structures.

Roentgenologic examination of our children gave important information which focused attention upon the thoracic lesions. The findings were such that they were not diagnostic of the condition, but there were certain features

which would probably permit us to recognize (or at least suspect) this abnormality if we encounter it again. In the first patient, loops of intestine containing air and gas were seen above the diaphragm to the right of the heart shadow, which led to a diagnosis of a diaphragmatic hernia (which indeed the patient had). After surgical reduction of the diaphragmatic hernia, some air-filled loops could still be seen on the right side of the chest (which on subsequent operation were shown to be due to the presence of the elongated and coiled diverticulum which remained in this area). In all three cases, there was some sort of a mass extending out from the mediastinum, usually to the right, which had the appearance of a long, narrow structure contiguous to and running along the mediastinum, or it had a more bulbous and rounded shadow, projecting out prominently from some part of the mediastinum. Because of obscuration by the normal cardiac or mediastinal shadows, it was not always possible to visualize the entire intra-thoracic part of a narrow diverticulum. Conversely, when the diverticulum had a large diameter, it could be seen to encroach upon the pleural cavity and to extend from the diaphragm to the apex of the chest. In one instance, this mass was very large and had a central indentation (produced by the azygos vein) which gave it a dumbbell shape. The shadows were opaque if the diverticula contained fluid, but in some instances they were radio-lucent whenever gas became pocketed in the pouch. It was of value to have film studies with the patient in an upright position to detect any tiny bubbles of gas, which were missed when film exposures were taken with the subject in a supine position. In only one instance did barium pass into the diverticulum during contrast study of the alimentary tract. Solid thoracic shadows might suggest neoplasm, teratoma, or indeed a gastrogenous cyst (duplication) of the esophagus. It has been our experience that most duplications of the esophagus do not communicate with the esophagus and hence do not contain gas. Therefore, the finding of air in a cystic structure projecting from the mediastinum has tended to make us think more of a diaphragmatic hernia, or of a diverticulum of the small intestine which projects into the thorax, such as we report herewith.

The surgical treatment of these abnormalities might lead the surgeon on a long therapeutic course requiring several operative procedures, or it might be possible to remove the entire lesion at one sitting. In our first case, being somewhat nonplused by the anomaly which was discovered, more operations were undertaken than perhaps were necessary. For the first stage, an abdominal approach was made, reducing the diaphragmatic hernia and suturing the diaphragmatic edges to the diverticulum to prevent recurrence of intestinal herniation. In a second attack, the chest was opened, but little could be accomplished because of the poor status of the baby. At a third operation, the right pleural cavity was again opened and the entire portion of the diverticulum which lay within the right half of the chest was removed. At a fourth stage, the left pleural cavity was traversed and the remaining thoracic part of the diverticulum was excised. In our second patient, the entire diverticulum

(intra-thoracic as well as abdominal) was removed in one stage, employing separate exposures through the right pleural cavity and the right flank. The baby stood this extensive maneuver in a very satisfactory way. In our third patient, the entire intra-thoracic portion of the diverticulum was removed at the first stage. At the next sitting, an anterior abdominal approach was made which gave extremely poor exposure and through which it was impossible to reach the diverticulum with any degree of satisfaction. At a third operation, an approach was made through the right flank; the intra-abdominal part of the diverticulum (from the duodenum) was so short that it appeared unnecessary and indeed unwise to remove it. Our experiences have shown that it will usually be impossible (with any degree of safety) to remove the infra-diaphragmatic portion of one of these diverticula through an anterior abdominal approach. Conversely, our limited knowledge indicates that the infra-diaphragmatic portion of such a malformation can be removed in some instances through a right flank incision (splitting a portion of the diaphragm if necessary to obtain adequate exposure).

Possibly, it is not necessary to remove all of the diverticulum in each case where this malformation is found. When the symptoms are due entirely to the accumulation of fluid and gas within the intra-thoracic portion of the diverticulum, it is probably sufficient to excise only that part which lies above the diaphragm. When, however, a diverticulum is lined by gastric mucosa which secretes hydrochloric acid and pepsin so that there is severe chest pain or when there is intestinal hemorrhage, it becomes highly desirable to remove the entire diverticulum if this is technically possible.

CASE REPORTS

Case 1.—L. C., A314627, a female infant, entered The Children's Hospital at the age of 3½ months with a chief complaint of intermittent episodes of vomiting and cyanosis since the age of 8 weeks. The family history was non-contributory. Birth was at full term; the weight was 5 lbs. 4 oz. For the first 2 months of life the infant appeared to be perfectly healthy.

At the age of 2 months the patient began to regurgitate about one feeding daily. During the following week an upper respiratory infection developed, and associated with this were episodes of cyanosis, lasting from a few seconds to 5 or 10 minutes, which were relieved by the use of oxygen. During the thirteenth week severe cyanosis frequently occurred after feedings. Roentgenographic examination showed loops of intestine in the right side of the chest and a diagnosis of diaphragmatic hernia was made.

Physical examination showed a well-developed and nourished infant in no distress at the moment. The neck was short and the patient resisted efforts to move the head. The chest was of normal size and shape; the expansion was good on either side. Breath sounds were audible over both lung fields, but in the lower part of the right side of the chest occasional peristaltic gurgling sounds could be heard. The abdomen was slightly scaphoid, but was otherwise normal. The remainder of the physical examination was essentially negative.

Roentgenographic examination following entry revealed multiple congenital anomalies of the cervical and upper thoracic vertebrae of a Klippel-Feil type. Several intestinal loops were seen in the right side of the chest. Two hours following a swallow of barium,

small amounts of the material appeared in the "intestinal" loops in the right side of the chest (Fig. 1).

Believing that the baby had a right diaphragmatic hernia, an abdominal exploration was carried out on February 18, 1947. Posterior to the liver, a defect about 1.5 cm. in diameter was found in the right side of the diaphragm, this opening being situated just above the crus. Several loops of ileum were pulled down out of this diaphragmatic defect. After this was finished there remained—to the surgeon's amazement—a *single* limb of bowel running up into the chest (Fig. 2). This had the diameter, thickness and general appearance of intestine. Tracing it downward, it was found to run behind the antrum of the stomach, alongside of the superior mesenteric vessels and to arise as a T-shaped side-arm from the jejunum (about 3 inches beyond the ligament of Treitz).

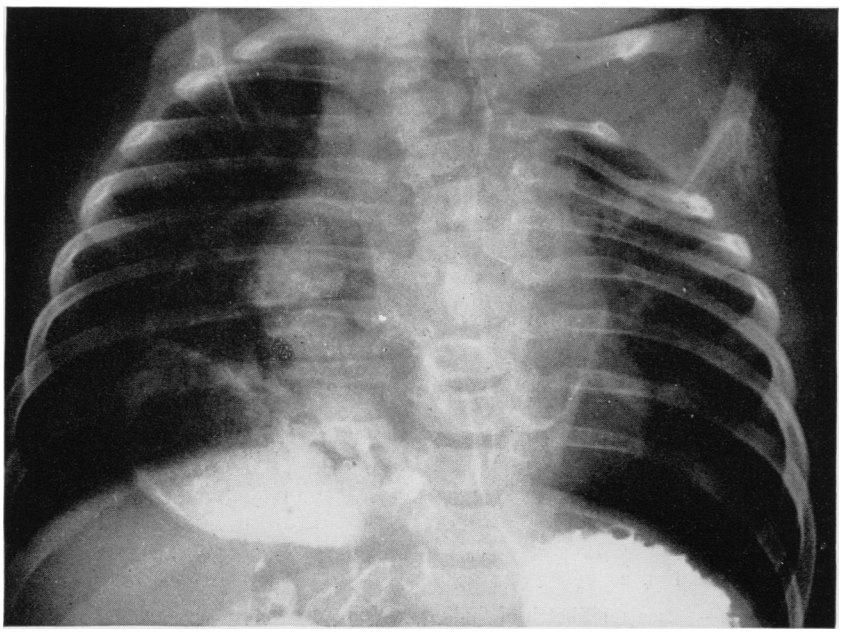

FIG. 1.—(Case 1.) Preoperative roentgenogram of chest showing air filled intestinal loops in the right side of the thorax.

This diverticulum had a wide communication with the jejunum. After making these observations, attention was again turned to that portion of the diverticulum which pierced the diaphragm. Traction showed that it was securely anchored within the thoracic cavity; it was impossible to determine the extent of and the attachments of the intra-thoracic part of the structure because of the small size of the diaphragmatic orifice. It seemed much too risky to attempt removal of the abdominal portion of the diverticulum without knowing more about its intra-thoracic extension. Therefore, it was decided to leave it in place, but to tack its surface to the edges of the surrounding diaphragmatic opening to prevent a recurrence of herniation through this region (Fig. 3). Immediately following this operation, roentgenographic examination still showed barium and air-filled loops of "intestine" in the right side of the thoracic cavity. Piecing together all our bits of knowledge, it was now obvious that these structures above the diaphragm (seen by roentgenographic means) must be a long, coiled diverticulum—the lower part of which we had viewed (at operation) in the abdominal cavity.

The following day a right transpleural exploration was carried out. The lung was found to be free and was unattached to the surrounding structures. A mass, somewhat larger than a golf ball, was seen extending up from the postero-lateral portion of the diaphragm, this being covered by a thin parietal pleura which had been pushed out from the mediastinum. Upon opening this sac, there appeared to be several loops of "intestine" which were quite adherent to one another; when these were disengaged we had a

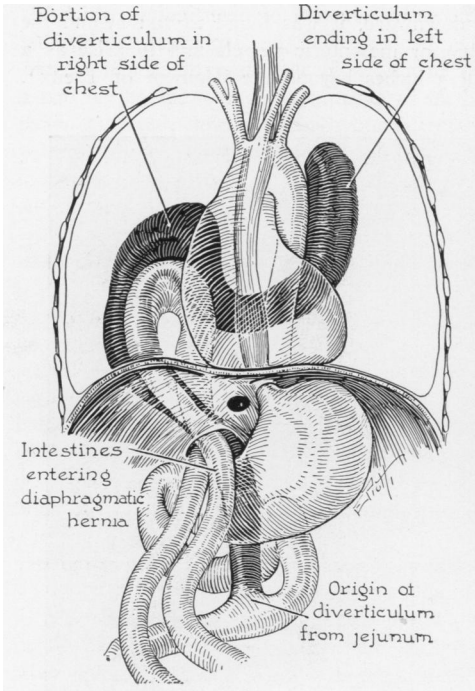

FIG. 2

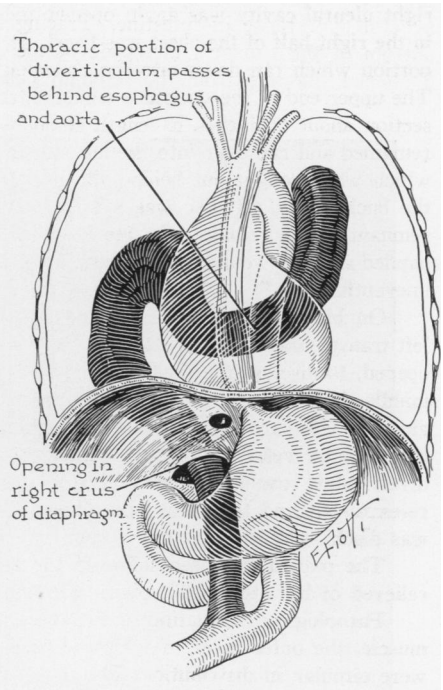

FIG. 3

FIG. 2.—(Case 1.) Sketch of findings which were gathered from roentgenologic investigations and from operations. There is a diaphragmatic defect on the baby's right. Intestinal loops had prolapsed upward through this orifice. In addition, a long diverticulum from the jejunum passed up through the diaphragmatic opening, entered the right side of the chest (extra-pleurally) and then coursed behind the esophagus and aorta to reach the left side of the chest, ending near the left apex of the thoracic cage.

FIG. 3.—(Case 1.) Status of findings *after* reduction of the diaphragmatic hernia—showing the long jejunal diverticulum extending up into the chest. Accumulation of fluid and gas in the diverticulum caused bouts of respiratory distress. In multiple stages, all of the thoracic portion of the diverticulum was removed, leaving the infra-diaphragmatic part.

tubular structure, 10 to 12 inches in length, one end of which came up through the diaphragm and the other end of which disappeared into the mediastinum! Dissection showed that its upper end went behind the esophagus and the aorta and kept on going into the left side of the chest. This tube, which was obviously a continuation of the diverticulum we had seen in the abdomen the day before, received many blood vessels from regional tissues. The baby's condition suddenly became poor and it was necessary to close the chest quickly. The liberated portion of the diverticulum was dragged out through the back of the wound.

Following this second operation, the child's condition was very precarious for several days. After the general condition had become stabilized, the exteriorized loop was opened so that barium could be injected into its two limbs. Film and fluoroscopic studies clearly showed that the diverticulum went downward to communicate with the jejunum and that its other end traversed the chest and ran up to the left of the spine to reach the left apex of the chest!

Unfortunately, the baby developed a diarrhea (which was epidemic in the ward at the time) and no further surgical attack was possible until April 8, 1947, at which time the right pleural cavity was again opened and the entire segment of diverticulum which lay in the right half of the chest was freed. It was then cut off at the diaphragm, closing that portion which ran down into the abdomen by turning it in with interrupted silk sutures. The upper end of the structure which entered the mediastinum was now cut off, so that a section about 10 inches in length could be resected and discarded. Into that part which remained and ran over into the left side of the chest, we threaded a small rubber catheter which was brought out behind the parietal pleura and passed through a stab wound in the back. This catheter was left in place to prevent any accumulation of fluid in the remnant which remained in the left side of the chest. The right lung was now re-expanded and the wound was appropriately closed. The course following this operation was uneventful.

On May 2, 1947, the remaining portion of the diverticulum was removed through a left transpleural thoracotomy. The lung was held forward and the mediastinal pleura was opened, to disclose the diverticulum coming from behind the esophagus and aorta in the middle third of the thorax. The diverticulum then took a sharp, upward bend to course along in the paravertebral gutter reaching almost to the apex of the chest. It received many blood vessels from regional structures but none of these was very large. The diverticulum could be liberated from its bed without much difficulty. The lung was re-expanded and the chest was closed. The convalescence was uneventful and the child was discharged home 12 days later.

The patient has been followed for 2 years since operation and has been completely relieved of her attacks of vomiting, cyanosis and dyspnea.

Pathologic examination of the specimen showed that it had a double coat of smooth muscle, the outer layer of which were longitudinal fibers and the inner layer of which were circular in distribution. The mucosal lining showed a variable picture and in most areas was quite similar to that of normal jejunum. In other zones the glands were more suggestive of those of colonic mucosa. In one small area the intestinal villi were covered by a pseudo stratified epithelium simulating respiratory epithelium, though they did not possess cilia.

Case 2.—R. M., A333598, a white male age 4 months, entered The Children's Hospital on August 13, 1948, with a chief complaint of pallor of 2 months duration and tarry stools of 11 days duration. The infant had been born at full term, with a birth weight of 6 lbs. 4 oz., and the early development appeared to have been quite satisfactory.

At 2 months of age the baby had increasing pallor and became increasingly irritable. The appetite became poor. At 4 months of age the child had loose, tarry stools and was hospitalized elsewhere for a period of 9 days. During this time the child was in a critical condition, the blood count falling to as low as 1.5 million and stools continuing to show evidence of great blood loss. They were frequently tarry and on multiple tests there was always a strongly positive guaiac reaction. With many transfusions the baby's general condition rapidly improved. A roentgenogram showed a large mass in the right side of the chest and the baby was sent to us for further investigation and treatment.

Physical examination revealed a fairly well-developed and nourished infant who was very pale but active and alert. His weight was 10 lbs. and 12 oz. There was a short, soft systolic murmur over the left side of the sternum. Otherwise, the heart and lungs were

normal by auscultation. The liver was palpable 2 finger-breadths below the costal margin and the spleen was easily palpable. Rectal examination revealed no masses but the stool was black and the guaiac reaction on it was strongly positive. Laboratory data revealed a hemoglobin of 10.4 Gm., a red blood count of 3,100,000 and a white blood count of 10,000. Roentgen examination showed a large dumbbell-shaped shadow extending out from the right side of the mediastinum, reaching from the diaphragm to the apex of the chest (Fig. 4). Visualized by a swallow of barium, the esophagus was seen displaced somewhat forward by the mass which extended into the posterior mediastinum. No barium flowed into the mass, but on several films bubbles of air could be seen within it, indicating that it probably possessed some sort of a communication with the alimentary

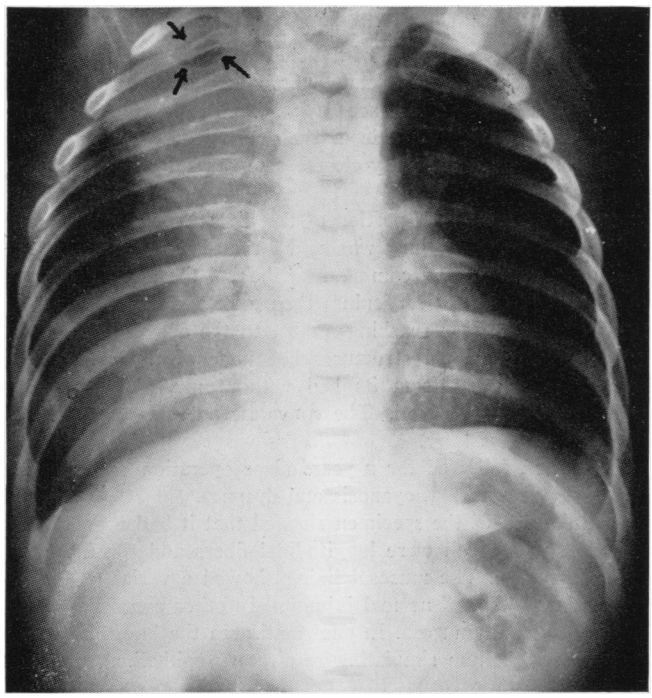

FIG. 4.—(Case 2.) Preoperative roentgenogram showing the large diverticulum projecting out from the right side of the mediastinum. Arrows indicate gas bubble in the structure. (The central groove or depression was caused by the azygos vein which constricted the diverticulum).

tract. No abnormalities were detected in the stomach, duodenum, or jejunum. There were developmental anomalies in the lower cervical and in the first two thoracic vertebrae.

During a period of a week, the baby required numerous transfusions to overcome the effects of continuing, massive bleeding from the gastro-intestinal tract. On August 20, 1948, a right, transpleural thoracic exploration was carried out. Behind the lung, and extending throughout the entire length of the chest, a cystic mass bulged out from the mediastinum; the middle portion of this was constricted by the azygos vein. It was covered by mediastinal pleura, which was now opened. The exposed structure was a thick-walled sac containing fluid and gas quite adherent to the apex of the chest.

It narrowed down inferiorly to a neck which had all the appearances of intestine as it pierced and ran through a defect in the posterior part of the diaphragm. With very little difficulty this entire structure was freed from its bed in the thorax. Inasmuch as the child appeared to be in reasonably good condition, it was decided to open the abdomen and examine the lower end of the diverticulum. A subcostal abdominal incision was made, running from the posterior axillary line slightly downward and well forward to the lateral border of the right rectus muscle. The liver was pushed forward and an

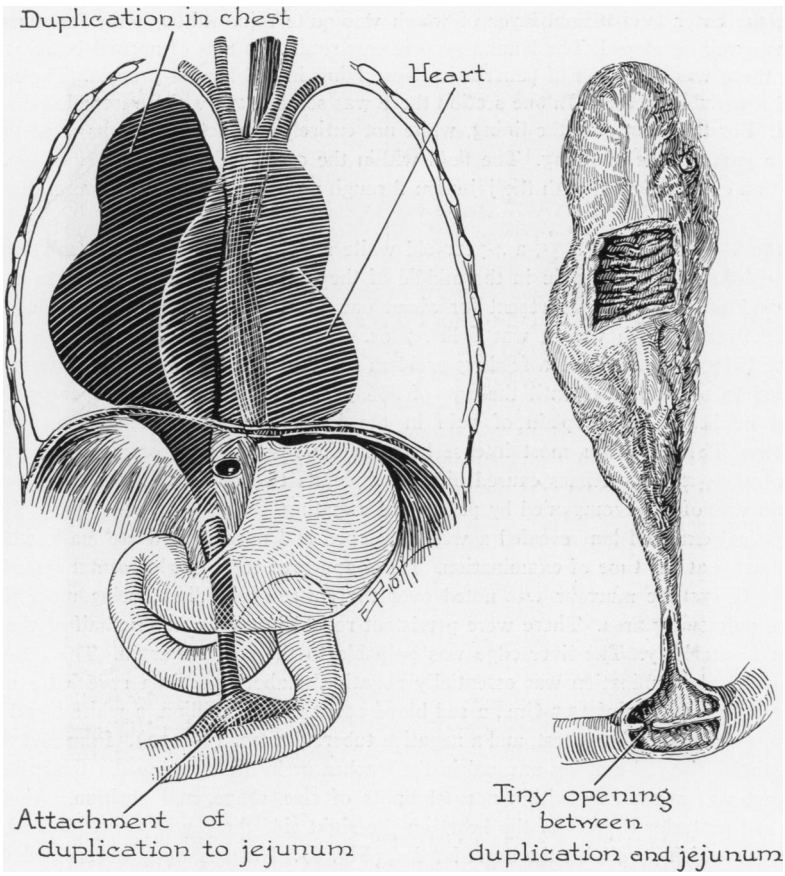

FIG. 5.—(Case 2.) *Left:* Sketch of large jejunal diverticulum which extended up into the right side of the thorax. The diverticulum was lined by gastric mucosa; its acid secretion caused jejunal ulceration and severe hemorrhage. The entire anomaly was excised by a combined transpleural and a transabdominal one-stage procedure. *Right:* Sketch of the specimen and segment of jejunum which were removed.

excellent view was obtained of the diverticulum which came down through the right crus of the diaphragm, coursed in front of the pancreas and then joined the jejunum about 2.5 cm. beyond the ligament of Treitz (Fig. 5). This diverticulum was freed from its attachments to the surrounding structures and was also cut away from the ring where it pierced the diaphragm. A segment of jejunum (several centimeters in length) which gave

rise to the diverticulum was resected, and the continuity of the jejunum was re-established by an end-to-end reconstruction. At this stage the entire diverticulum, including its thoracic portion, its intra-abdominal part, and the segment of jejunum from which it arose, could be discarded. The defect in the diaphragm was quickly repaired. The lung was re-expanded and the chest wound was closed. Finally, the abdominal wound was closed.

The postoperative course was uneventful, convalescence was rapid, and the patient was discharged from the hospital on the eleventh postoperative day.

Pathologic examination of the specimen showed it to have a double coat of smooth muscle, the outer longitudinal layer of which was quite thin, although the inner circular layer was well developed. The lamina propria was similar to that of normal bowel. In one section there was an island of pancreatic tissue lying in the lamina propria. The mucosa showed a variable picture. In one section there was some tissue which resembled duodenal mucosa. For the most part the lining, while not entirely characteristic, was most suggestive of a gastric type of lining. The fluid within the diverticulum had a pH of 3.9. The duplication communicated with the jejunum through an opening about 0.5 cm. in diameter.

Case 3.—R. W., A341531, a 4-year-old white male, entered The Children's Hospital with a chief complaint of pain in the middle of the back, which had been aggravated by eating and which had been present for about one year. Birth was at full term, with a breech delivery. Birth weight was 6 lbs. 7 oz.

The baby had presented a feeding problem for the first few months of life and had continued to spit up food until the age of 2½ years. One year prior to entry in this hospital he began to complain of pain in the back, especially during and following deglutition. This pain was most intense between the scapulae; it became more frequent in appearance, and sometimes caused bitter complaints two or three times during a day. The pain was often accompanied by pallor and sweating.

Physical examination revealed a well developed and nourished white male, who was in no distress at the time of examination. There appeared to be slight mental retardation. A grade II systolic murmur was noted over the entire precordium, being more intense over the pulmonary area. There were persistent ronchi in the lower one-half of the right lung field anteriorly. The liver edge was palpable to the costal margin. The remainder of the physical examination was essentially negative. Laboratory data revealed a normal urinalysis, hemoglobin of 13.7 Gm., a red blood count of 4.85 million, a white blood count of 8,500, a negative Hinton test, and a negative tuberculin test (1-1000). Film and fluoroscopic studies showed nothing unusual in the trachea or in the upper mediastinal shadows. The heart was apparently within normal limits of size, shape, and position. Along the lateral and posterior aspects of the heart on the right side there was a well-defined, soft-tissue mass which paralleled the heart border (Fig. 6). No pulsations were noted in this mass, and no definite alteration in its contour could be noted when the patient was placed in different positions. The barium-filled esophagus showed a minimal deformity in its lower third; its right border was slightly compressed.

Exploration of the right pleural cavity was carried out on February 21, 1949. The lung was held forward, and a long, sub-pleural, tubular structure was found, running along the mediastinum, extending from diaphragm almost to the apex of the chest. As this came up through the right crus of the diaphragm it had the size, thickness and general appearance of intestine. In its mid-portion, it ballooned out to 8 to 10 cm. in diameter, had a thicker wall and was quite adherent to surrounding viscera. In its upper third, its wall was several times the thickness of intestine, was very congested and vascular, and had dense, hemorrhagic adhesions to the esophagus and regional structures. (This reaction had come from the unneutralized hydrochloric acid and pepsin within its lumen).

Though the dissection was very difficult, the entire intra-thoracic part of the diverticulum was excised. A catheter was led into the infra-diaphragmatic part of the diverticulum and this tube was brought out through a stab wound in the back of the thorax. The right lung was now re-expanded and the chest was closed appropriately. From this operation the child made a rapid and satisfactory convalescence. A thin barium mixture was injected through the catheter and it was obvious that there was some sort of a connection with the upper part of the intestine, but the exact location of this union was difficult to determine. The catheter was then pulled out.

Believing that an infra-diaphragmatic segment of considerable length might still remain and that it was desirable to remove it, the abdomen was explored on March 4, 1949. A vertical opening was made through the upper part of the rectus muscle, but a totally inadequate exposure was obtained. The diverticulum could be identified coming through the right crus of the diaphragm, but since it was tucked in behind the vena cava and the gastrohepatic ligament it was utterly impossible to view it completely and trace it adequately. The examination was especially unsatisfactory because the pancreas and the

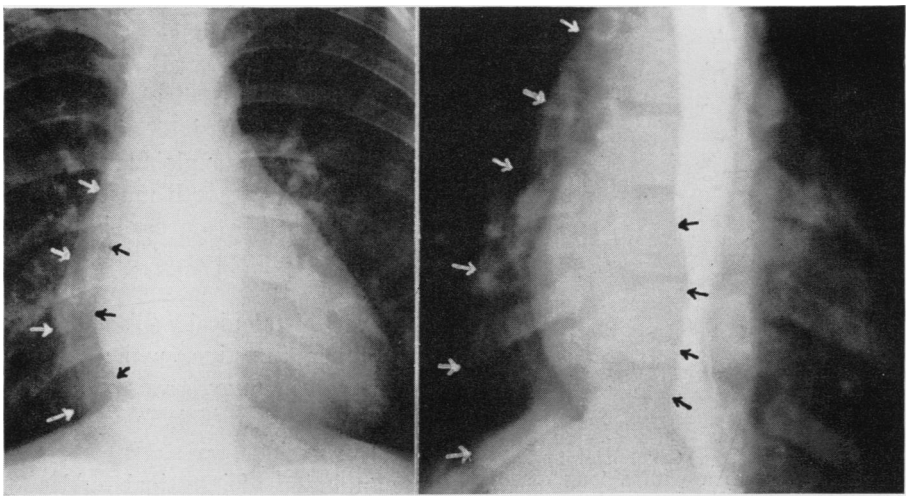

FIG. 6.—(Case 3.) *Left:* Roentgenogram of the chest, showing mass protruding from the right side of the mediastinum (right border of heart indicated by black arrows. Wall of diverticulum shown by white arrows). *Right:* Heavier roentgenographic exposure, with barium in the esophagus, showing the thoracic mass pressing upon the esophagus (arrows outline borders of the diverticulum).

entire duodenum were apparently displaced upward against the under surface of the liver in an abnormal fashion. Because of the difficulties encountered, the exploration was abandoned.

A second abdominal operation was carried out on March 15, 1949; with the boy turned well up on his side, an incision was made in the costovertebral angle, running downward and forward, and the tenth, twelfth and eleventh ribs were removed. The liver could be displaced forward and the crus of the diaphragm viewed fairly well. The diverticulum which came through it was quite short and, within one or two centimeters, communicated widely with the posterior surface of the first part of the duodenum (Fig. 7) which had been drawn up against the diaphragm by this anchoring attachment. After carefully evaluating the situation, it seemed that the risks of removing so short a diverticular stump far outweighed the possible benefits of such an excision. It was therefore decided to

leave this remnant, believing that its wide communication with the duodenum would allow reflux of duodenal contents into it in such a way as to neutralize any acid which it might be secreting. Following this exploration the child made a rapid recovery and was discharged 8 days later. He was completely relieved of the chest pain for which he had entered the hospital.

Pathologic examination of the specimen showed that it had a two-layered coat of smooth muscle. In some sections there appeared to be an additional irregular third coat of smooth muscle. The muscularis mucosae was well defined. There was a wide submucosa of loosely arranged tissue, containing islands of fatty substance. The lining was quite similar to that of a normal gastric mucosa. Numerous acid-secreting cells were found throughout the specimen.

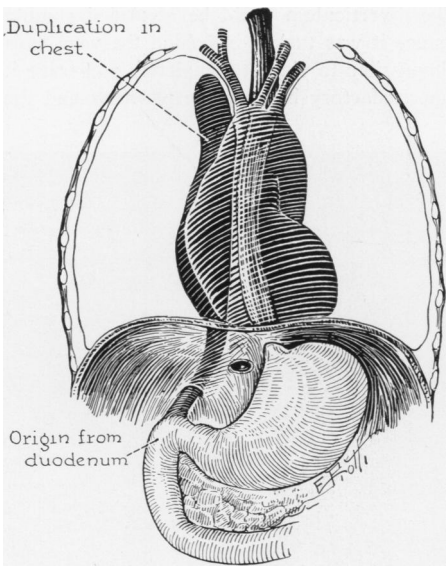

FIG. 7.—(Case 3.) Sketch of findings of duodenal duplication with a long extension into the chest. The diverticulum was lined by gastric mucosa which secreted a fluid containing hydrochloric acid and pepsin. This unneutralized material set up an intense reaction in the diverticular wall and adjacent mediastinum so that the child had severe pain during deglutition. All of the thoracic part of the diverticulum was removed. The short infra-diaphragmatic part was not excised.

SUMMARY

Descriptions are made from three children who had unusual malformations in the form of long, duodenal or jejunal diverticula which coursed upward, pierced the right side of the diaphragm, and extended far up into the chest. These elongated or globular, hollow structures had smooth muscle coats and were lined by mucosa similar to that of some portion of the alimentary tract. In one of them the lining was histologically like that of the upper intestine, while in the other two the mucosa was gastric in type. The diverticula gave symptoms in various ways. In one, the accumulation of intestinal fluid and gas within the intra-thoracic portion of the structure gave pressure on thoracic organs and led to intermittent dyspnea and cyanosis. In the second case, the formation of large amounts of gastric juice within the diverticulum produced ulceration in the jejunum from which there was hemorrhage of almost exsanguinating degree. In a third patient, the pocketing of unneutralized gastric juice within the sac brought on inflammatory changes within its wall and reaction in surrounding structures which resulted in chest pain. Roentgenologic examination of these three patients showed variable features, but in each there was a shadow projecting out from the mediastinum which appeared to be either a solid mass or a gas-containing viscus.

Under some circumstances, the symptoms from one of these diverticula are such that excision of the entire malformation is desirable, but in other

cases complete relief can be obtained by removing only the thoracic portion of the diverticulum.

Surgical attack on such an anomaly might require multiple-stage procedures, depending upon the extent of the diverticulum, the condition of the subject, and the appropriateness of the operative exposure which has been chosen. It is sometimes possible to remove the intra-thoracic and the infra-diaphragmatic portions of the diverticulum in one operation.