

THE DIAGNOSIS OF DIAPHRAGMATIC HERNIA.

BY H. Z. GIFFIN, M.D.,

OF ROCHESTER, MINNESOTA.

Attending Physician to St. Mary's Hospital.

IN obtaining clinical histories from patients, it is well to inquire as to former injury much as one would ask about previous disease or operation. In this manner a clue may be obtained which will occasionally lead to eliciting data of vital importance in the diagnosis. This point is forced upon one's attention in reviewing the reported cases of diaphragmatic hernia. The history of trauma is very important evidence, as will be shown later.

For a discussion of the embryology, anatomy, and pathology of diaphragmatic hernia and related conditions, the reader is referred to articles by Sailer and Rhein, Strüppler, Königer, Beltz, and Becker. Further discussion on the diagnosis will be found as well. It will be impossible to give credit in the text to all authors whose papers have been reviewed. German clinicians have been very thorough in their study of diaphragmatic hernia, and we are indebted to them for most of our information. The fact that little has been written in English upon the differential diagnosis has led me to prepare this discussion.

Many diaphragmatic hernias are congenital, but most of these have been found in stillborn babes or in infants. Hernia occurs through the various normal apertures of the diaphragm. Hernia into the pericardial sac has been reported. Right-sided hernias have, as a rule, been small and have contained a small knob of liver. The stomach has been found in the right side of the chest in one instance. Nearly all diaphragmatic hernias, however, are left-sided, and the subject will therefore be reviewed from this stand-point. Most important for diagnosis are the congenital hernias of adults and traumatic hernias.

About 650 cases of diaphragmatic hernia have been re-

ported. Strüppler collected 500 cases in 1901. One hundred and seven reported cases have been found since then, and in addition 41 references have been collected which the writer has been unable to confirm personally. Most of these were either congenital hernias of babes or symptomless hernias discovered at autopsy. It would seem that 15 cases were diagnosed correctly during life. It is safe to say, however, that many mistakes have been due to the fact that the physician was unprepared for the condition; that the symptoms and signs of diaphragmatic hernia were often quite clear but were not elicited because of lack of familiarity with them. On the other hand, an occasional case has been reported in which all the refinements of Teutonic technic have failed to differentiate the condition.

The most important and difficult differentiation to make is that between diaphragmatic hernia and *elevation of the diaphragm (eventration)*. "Eventration" of the diaphragm was applied by Petit in 1790 to the condition of chronic idiopathic unilateral elevation of the diaphragm described by him. About 20 cases have been reported in the literature. As Königer suggests, it is not a good term surgically. The surgeon understands by eventration the condition in which a large part of the abdominal viscera is outside the peritoneal cavity. In fact, the word eventration might well be applied to diaphragmatic hernia, but not to high position of the diaphragm. Elevation of the diaphragm would be a better term; it is concise and its meaning is clear.

Elevation of the diaphragm is not an operative condition. Diaphragmatic hernia is generally surgical. The importance of deciding between the two conditions is therefore increased. Cases of elevation have been diagnosed hernia and unnecessarily operated upon.

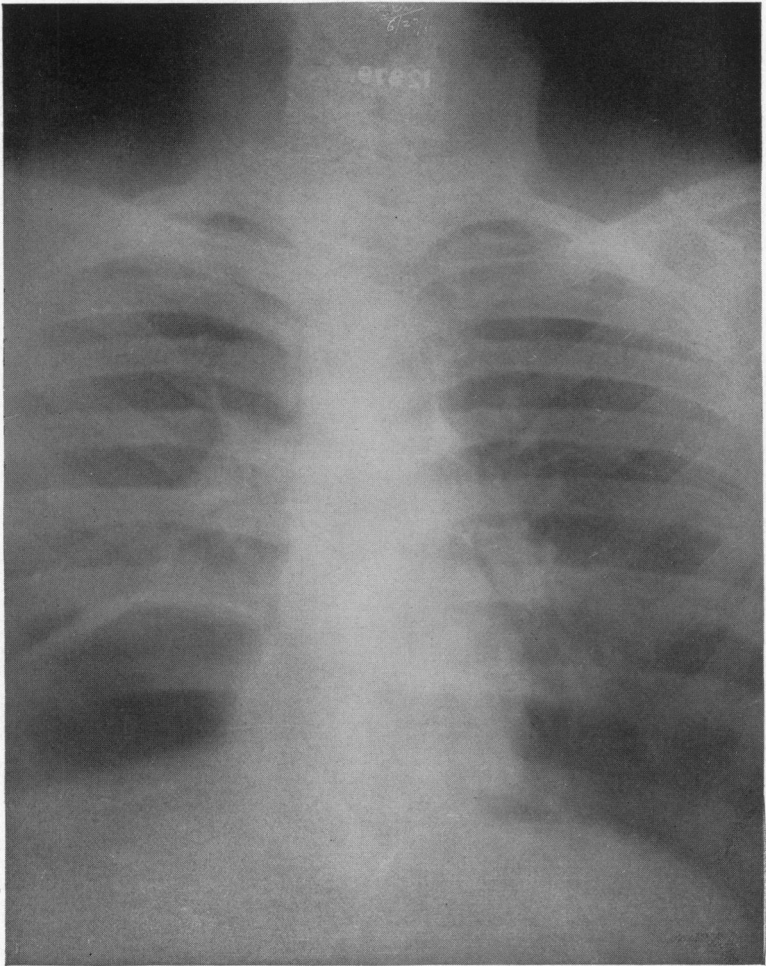
The diagnosis can best be discussed in a consideration of (1) the clinical symptoms, (2) the physical signs and (3) the radiographic and fluoroscopic findings.

If a history of severe trauma be elicited,—a crushing injury to the lower thorax or upper abdomen, as would occur if a man were caught between buffers; a severe blow to the upper

abdomen or lower thorax, as in being struck by a flying plank; a severe twist with consequent strain upon the organs of the upper abdomen and the diaphragm, as in being jerked suddenly from one position to another; a sudden doubling of the body with chest between knees, as in a sand or gravel slide; a penetration of tissues in the region of the diaphragm, as in a stab wound,—the existence of rupture of the diaphragm should be suspected. In the acute condition, marked dyspnoea with severe upper abdominal and left thoracic pains, possibly with symptoms of intestinal obstruction and hæmatemesis, completes the clinical picture.

Chronic cases of hernia, either congenital or traumatic, may give a less striking symptomatology and a history of much less severe injury. In this they approach the symptoms of elevation of the diaphragm, where abdominal pain, dyspnoea, and vomiting, though less severe, may recur in attacks, and these may be worse after trauma without rupture being present. Elevation is generally a congenital condition. A prominent symptomatology may only follow trauma. Dyspnoea, pain, indefinite gastric complaints may be of varying grades. Hæmatemesis has been reported. It is in these chronic cases then that the physical findings and radiographic and fluoroscopic study are more important.

Tympanitic percussion note, distant breath sounds, gurgling and tinkling sounds over the left lower chest, with hyper-resonant note and normal or slightly altered sounds over the left upper chest are common to both conditions. The heart is displaced to the right. In diaphragmatic hernia Litten's sign may be absent, and it has been suggested that the line of tympany may be less movable than in elevation. Dulness below tympany has been noted in diaphragmatic hernia and is probably explained in one case on record by the presence of spleen and in another by omentum. After giving a Seidlitz powder the signs may be much clearer and expansion of the stomach upward is likely to be more decided in hernia. Filling the stomach with water will cause partial flatness in place of tympany. Air or water pumped into the colon will likewise affect the tympany in the chest, if the



June 26, 1911. Case, diaphragmatic hernia, with the stereoscopic radiographs made of patient in the vertical position, the sternum next to the X-ray plate, care being taken to avoid any rotation of the spine on its long axis. The central focus corresponds to the level of the seventh dorsal vertebra.

We are viewing the thorax through from behind, therefore the right side of the print represents the right side of the thorax. These prints are facsimile reproductions of the original plates.

Note the position and outline of the pericardial shadow. The heart inclines strongly toward the right, its right border extending a greater distance to the right of the midsternal line than does the left border to the left of the spine.

Both hiluses are abnormally dense, the left being markedly enlarged. Both apices are clear, and the pulmonary tissue is normal in all three right lobes and in the upper left lobe.

In the lower portion of the left thorax can be seen clearly a curved white line of greatly increased density. The proximal end of this line is opposite the level of the spinal juncture of the eighth rib on the left side. From this point the line curves outward along the eighth interspace to the ninth rib. Between this line and the upper border of the tenth rib is seen a dark area of greatly decreased density, through which one can clearly distinguish branches from the lower pole of the left hilus. The costal portions of three ribs are also visible. The left margin of the pericardial shadow is not clearly defined.

Note the clear-cut outline of the dome of the diaphragm to the right of the spine and compare it with the faint, indistinct outline on the left of the spine, which is to be seen just below the tenth rib.

The unusual appearance of the lower portion of the left thorax attracted our attention and suggested strongly the probability of a hernia of the diaphragm. A study of the stereoscopic plates supported this suspicion, and it was deemed important to establish the position of the stomach, for it seemed likely that the dark shadow below the abnormally placed curved line was due to gas in the stomach. With this end in view an emulsion of subcarbonate of bismuth and acacia was given the patient by mouth and a second set of plates made immediately, the patient being in the vertical position. (See Fig. 2.)

FIG. 2.

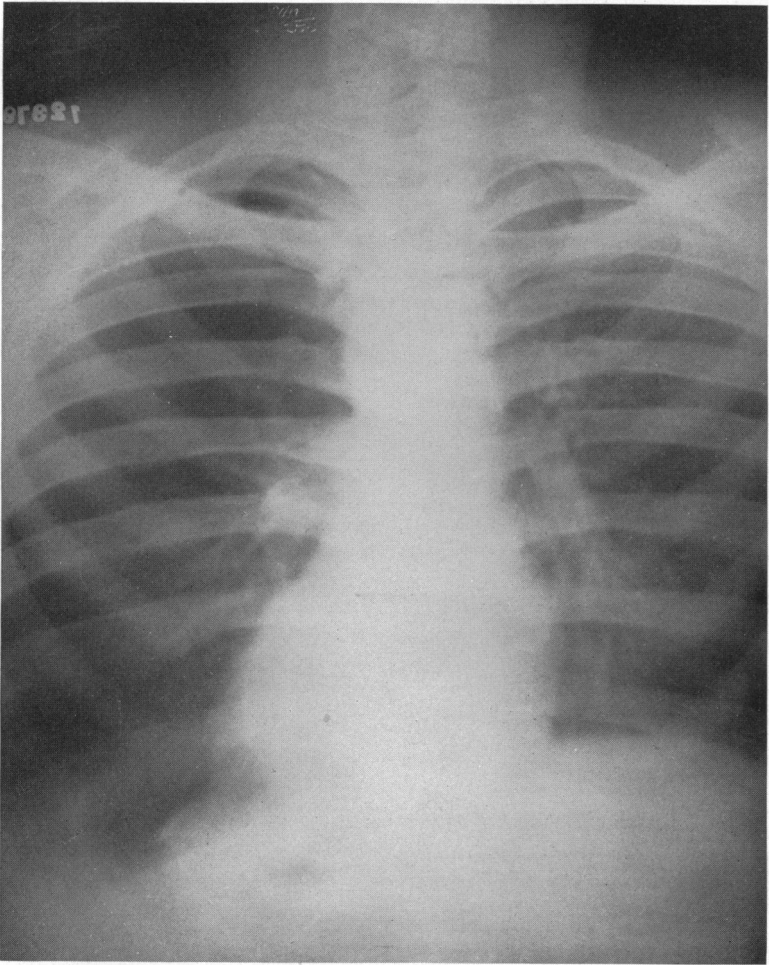


Radiographed immediately after the ingestion of bismuth subcarbonate emulsion. Compare with Fig. 1.

Note the line of demarcation between the white dense area and the dark area lying above it. The white shadow represents bismuth in the stomach, the upper border of the shadow representing the surface level of the emulsion. Above the bismuth is seen the gas bubble of the stomach. This is limited above by the wall of the stomach which we recognize as the curved line described in Fig. 1. Note the faint outline of the bismuth lining the œsophagus. This can be traced upward to the limit of the plate. Figs. 1 and 2, together with the history, confirmed the diagnosis of hernia of the diaphragm.

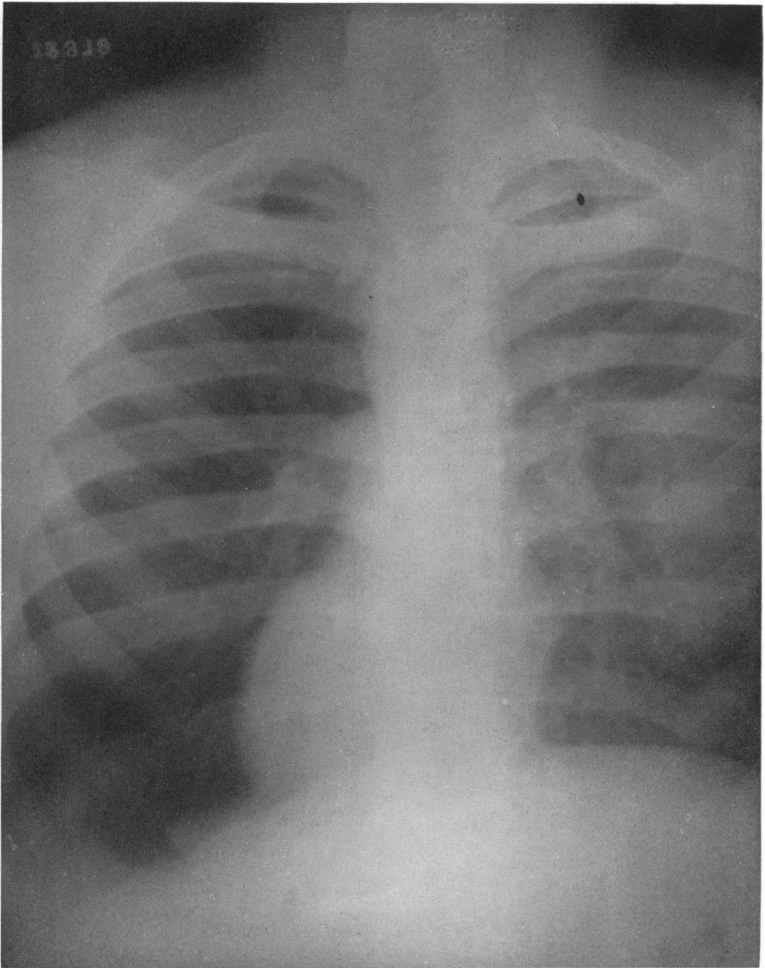
Important diagnostic points demonstrated by the radiographs, Figs. 1 and 2: (1) the presence of a dark circumscribed shadow situated above the indistinct outline of diaphragm on the left side and bounded above by a curved dense band which does not maintain the dome shape typical of the normal diaphragm line, and limited mesially by the left border of the heart which is displaced strongly to the right; (2) the presence of the shadows of the lower branches of the left hilus showing through rarified area; (3) the location of the stomach and its great bubble by bismuth ingestion method.

FIG. 3.



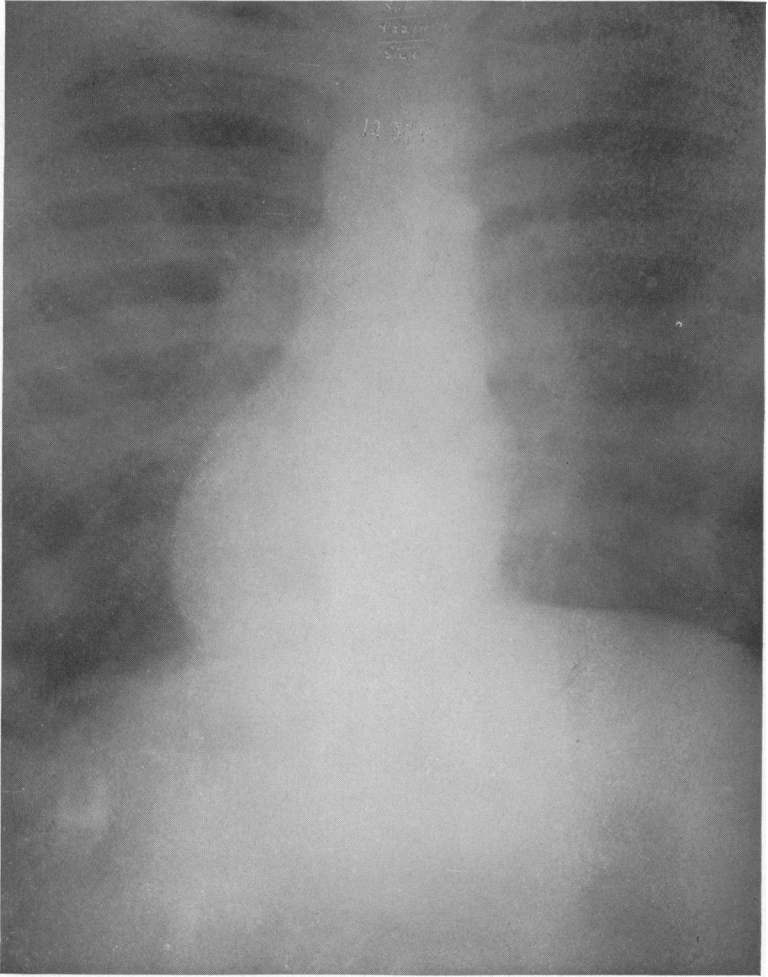
Two weeks after operation Compare with Fig. 1. Patient's pose is the same as in Fig. 1. (1) Note the absence of the curved white line described in Fig. 1; (2) the dense white area just to the left and below the nose of the heart represents the operation scar; (3) the heart has returned almost to its normal position; (4) there is a marked difference in density in the two sides of the chest; the left is darker, indicating a pneumothorax and partial collapse of the pulmonary tissue incident to the operation upon the diaphragm.

FIG. 4.



Three weeks after operation. Compare with Figs. 1 and 3. (1) The outline and position of the heart remain the same as in Fig. 3; (2) the shadow of the scar is greatly reduced in size; (3) the shadow of the pneumothorax has greatly decreased; (4) the pulmonary tissue has regained much of its normal appearance. Compare the right and left sides of the thorax.

FIG. 5.



Six and one-half weeks after operation. Compare with Figs. 1, 3, and 5. (1) The heart has returned to the normal position; (2) note the distinct change in the appearance of the scar of the diaphragm; it is much smaller; the outline of the diaphragm upon the left side is more nearly regular than in the preceding plates; (3) practically all trace of pneumothorax has disappeared and the lung tissue has resumed its normal appearance. Compare the left lung with the right.

colon be part of the hernia; if this finding be definite it may be regarded as an important point in favor of hernia. Examination after changes in position may furnish some evidence.

In radiograms of either condition the most noticeable abnormality is the existence of a curved shadow line with concavity downward in the left chest, and the problem is to determine whether this shadow line represents stomach wall as in hernia, a high diaphragm as in elevation, or both stomach wall and diaphragm as in elevation. (1) The shadow of elevation generally maintains a typical dome-shape whether it be low or high, or whether the radiograph be taken before or after distention of the stomach with CO_2 . The shadow of hernia may vary in outline, may be irregular or incomplete. (2) In diaphragmatic hernia the mottled appearance of lung tissue is visible through the gas contained in the stomach. This is not noted in elevation of the diaphragm even after extreme distention. These two observations are the most important ones in the radiographic differential diagnosis. If two curved shadows be present a radiographic or fluoroscopic examination after distention of the stomach should indicate which line is stomach and which diaphragm; if the lower line be stomach it will move up against the diaphragm line, and the pyloric end of the stomach will then unfold; if the upper line be stomach, distention upward into the chest will be almost unlimited. If the bow line shadow represent both diaphragm and stomach, distention will cause merely the above-mentioned unfolding of the pars pylorica.

The passage of stomach tube or lead bougie with subsequent radiogram does not seem to have yielded much additional information. Estimation of the intragastric pressure during inspiration and expiration in the two conditions has been attempted, but the results are not clear.

A series of X-ray plates following a bismuth meal should add some confirmatory evidence. The stomach may thus be identified as an organ lying in high position. The colon is almost always included in a hernia, and a plate showing bismuth in the colon above the level of the bow line in the chest would be conclusive evidence of a diaphragmatic rupture. As

far as I have been able to learn, this point has not been emphasized in the literature, but *a priori* it would seem true.

Fluoroscopic examination is useful in studying the movements of the shadow line. The excursion of the diaphragm line in elevation approaches in character the normal. On the other hand, congenital hypoplasia of the left lung is usually present with elevation of the diaphragm and consequently the movements of the diaphragm line may be far from normal. Indeed, a diaphragm shadow may not move with respiration in elevation and a stomach line may move in hernia. A "paradoxical expiratory displacement" has been noted in diaphragmatic hernia. During forced inspiration the right diaphragm descends normally, while the boundary line in the left chest ascends. During forced expiration the right diaphragm ascends while the boundary line on the left descends. Upon forced expiration by contraction of the abdominal muscles the shadow line on the left is again forced high into the chest. The movements on the left occur a little later than those on the right. This phenomenon has not been described in unilateral elevation in which the movements of the shadow line are likely to approach the normal in character, though they are less free in excursion. (See Becker's article, p. 186 *et seq.*).

The diagnosis then of diaphragmatic hernia from elevation of the diaphragm may, at times, be very difficult and may require all of our technical resources. It is quite likely that *rudimentary elevation* is more common than at present suspected and the condition should be more carefully looked for by clinicians.

The differential diagnosis of *pneumothorax* and diaphragmatic hernia is discussed in articles by LeConte and Ingalls. Particularly may there be difficulty when the pneumothorax is the result of injury. Dyspnoea may be present, and severe pain be experienced. The note over the left chest may be tympanitic, and tinkling sounds be heard. The tympany, however, is likely to extend to the top of the lung, and the breath sounds may be amphoric, vague, faint, or absent. In diaphragmatic hernia breath sounds and vocal fremitus

are not generally diminished, and the metallic sounds are associated with peristalsis rather than respiration. The positive coin test is more constant in pneumothorax. Vomiting is likely to be less continuous. Bulging of the interspaces upon closure of the glottis may outline the lower limit of the lung. The radiogram will generally furnish conclusive evidence of an unbroken diaphragm line. Pneumothorax has protean characteristics, however, and diaphragmatic hernia should always be considered before a diagnosis of pneumothorax is made.

Pneumothorax from rupture of the stomach in congenital diaphragmatic hernia with no history of injury has been reported. Such a condition might possibly be suspected after very careful consideration, but it is difficult to see how a diagnosis could be established.

Hydropneumothorax should be less difficult of diagnosis, especially if fluid be present in a moderately large amount. If succussion be obtained, it must be determined that it is produced in the pleura and not in the stomach. A movable line of dulness with signs of pneumothorax and a horizontal fluid line in the radiogram would be conclusive. Leucocytosis and symptoms of pus infection in addition to the findings described above would point to *pyopneumothorax*. Exploratory puncture would be conclusive.

Temporary elevation of the diaphragm has been reported. It has been thought to be the result of an affection of the phrenic nerve. In time the diaphragm line resumes its normal position.

A large cavity in the lower lobe may give metallic sounds and dyspnoic symptoms. The cavity may develop suddenly after the expectoration of large amounts of sputum. The radiogram would show evidence of lung involvement elsewhere, and it should be possible to recognize the diaphragm line.

The name *subdiaphragmatic pyopneumothorax* has been given to the condition in which a pus cavity beneath the diaphragm contains gas. The most common cause is perforating ulcer of the stomach or duodenum. The diaphragm may be

elevated as high as the third rib. There may be tympanic resonance over the area of the cavity. Metallic tinkle, succussion splash, and coin sound may be present. The chief difficulty would be in differentiation from pyopneumothorax. A history pointing to pre-existent abdominal disease and radiographic findings of elevation of the diaphragm should differentiate the condition.

In the case reported herewith, recurrent colic would have suggested *gall-bladder disease* or other abdominal lesion had a history of trauma not been obtained or had the findings on physical examination of the left thorax been less definite.

Pyloric stenosis has occurred from mechanical conditions in congenital diaphragmatic hernia, and the predominance of gastric symptoms has led to a suspicion of *ulcer*. *Esophageal stenosis* may be caused by acute hernia.

Four cases of diaphragmatic hernia have been operated upon at St. Mary's Hospital (Mayo Clinic). Three of these were reported in 1909 by Beckman. The case seen since then was diagnosed from the history and clinical findings by the writer and independently from a study of the radiograms by Selby.

L. J. (a55100), male, aged twenty years. Consultation June 26, 1911. Patient had been caught, together with four other men, two of whom were killed, in a sand slide one year previously; he was instantly and forcibly doubled up with his head between his feet, was unconscious for five to ten minutes, but easily revived. The stomach was empty at the time of the accident. He experienced no pain for a half hour after the injury. Then pain over the entire abdomen and chest became severe; shortness of breath was a prominent symptom, complaint gradually localizing to the upper abdomen and left side of chest and continuing together with some shortness of breath for two weeks. The patient remained in bed for five weeks. Pain across the lumbar region was also complained of, and the patient could not draw his legs up as he lay in bed for two weeks. Bladder and bowel control was good. He was able to walk in ten weeks. After this at times he complained of "sticking" pains across the abdomen and in the left side of the chest, and a sensation of the "stomach being lifted up under the chest." During the year which elapsed between the time of injury and the examination,

the patient had had attacks of severe epigastric pain lasting for an hour or two, with much bloating, sour eructation, and nausea, but no vomiting nor symptoms of intestinal obstruction. Pain often began in the right lower abdomen and later localized in the upper abdomen and left side of the chest. Soda gave some relief, but food did not. These attacks came at any time without relation to food and recurred every few weeks. There had been ten pounds loss of weight. Because of these attacks he consulted a physician. The family history and personal history were negative.

On physical examination a dull tympany was noted over the left side of the chest downward from the level of the sixth spine behind and anteriorly to the midaxillary line. Expansion did not seem to be markedly affected. Vocal fremitus was present over this area, though slightly diminished. The breath sounds could be heard, but were quite distant. Tinkling sounds could also be heard, and these were close to the ear and seemed to occur with peristalsis. Anteriorly from the midaxillary line the percussion note was quite dull, so that the left border of the heart could not be outlined. Heart dulness, however, extended three inches to the right of the midsternal line. Above the second rib in front and the spine of the scapula behind the percussion note was hyper-resonant and breath sounds harsh. The right lung seemed normal.

The X-ray prints, together with their descriptions, by J. H. Selby, will explain the condition found. It is necessary only to point out that the diagnosis from the radiograms was made chiefly from (1) the fact that the bow line in the left chest did not conform in outline to the dome shape maintained in elevation of the diaphragm, and was irregular and indefinite, particularly at its outer portion; and (2) the fact that lung tissue could be seen through the gas bubble below this line, which is not observed in elevation.

Operation July 5, 1911: An oval-shaped opening in the left half of the diaphragm, near the crux, large enough to admit the hand easily, was found. The hernia contained stomach, large intestine, spleen, small intestine, and the tail of the pancreas. (The presence of spleen probably explains the dulness found anteriorly on percussion of the chest.) The lung was completely collapsed. The stomach was distended and its walls were hypertrophied, doubtless as the result of mechanical obstruction. Nearly all of the transverse colon and 12 feet of the jejunum were

in the chest. The spleen was twice the normal size and most difficult to reduce. It was torn and required catgut sutures. Tremendous traction was exerted by the chest cavity so that the stomach and spleen showed a marked tendency to be drawn back into it. The opening into the pleural cavity was sutured with heavy linen for three or four stitches, then interrupted sutures were placed. The suture line was five inches long. The posterior margin of the opening was difficult to catch, the anterior quite easy. Additional sutures were placed where there was evidence of air aspiration along the suture line.

It is impossible to determine what portion of the abdominal contents became a part of the hernia as the result of opening the abdomen. In view of the evidence of decided negative pressure in the chest upon the attempt at reduction of the hernia, it seems likely that the original hernia was increased in size by the additional pressure from below. The lung was found more nearly collapsed at operation than one would have expected from the extent of visible lung tissue in the radiograms.

Four days after operation the patient was quite comfortable and easily examined. The temperature was nearly normal. There were no signs of fluid. Over almost the entire left chest the percussion note was exceedingly resonant, tympanitic, and so drum-like that it approached the quality of a musical tone. Vocal fremitus could be felt with difficulty and breath sounds were distantly transmitted. The heart remained displaced. A pneumothorax was evidently present. One week later there was some change in the percussion note. It continued, however, to be drum-like and very resonant. Breath sounds could be heard a little closer to the ear save at the extreme left base. Cardiac dulness was almost normal in outline. The patient left the hospital on the thirteenth day. He was examined repeatedly up to the time of his discharge six and one-half weeks after operation. No complications developed. The lower portion of the lung slowly completed its expansion. An X-ray plate taken six and one-half weeks after operation is reproduced. This shows almost completed expansion of lung tissue. The return to the normal is remarkable, when one considers that the lung had been partially collapsed for one year. The patient is at present enjoying excellent health.

On recapitulation then it is seen that a history of severe trauma, followed by upper abdominal and left thoracic pains,

dyspnoea, and vomiting, together with physical findings pointing to displacement of the stomach or intestine into the lower left chest and of the heart to the right, will ordinarily be sufficient for making a diagnosis of diaphragmatic hernia. If the history and findings be definite, this will be true whether the patient is seen immediately after injury or some time later. Röntgen ray findings will then be mostly of corroborative value. When, however, the injury has been less severe and the symptoms and signs less definite, and again in most cases of congenital diaphragmatic hernia, radiographic and fluoroscopic examinations must be relied upon for a differentiation of the condition. In interpreting the plates (1) a destruction of the definite dome shape characteristic of the normal diaphragm line, (2) the appearance of lung tissue through the gas bubble in the left chest, and (3) the demonstration of bismuth in the colon above the level of the bow line of the chest constitute the most important evidence in favor of hernia of the diaphragm. By fluoroscopic examination the "paradoxical respiratory phenomenon" may be demonstrated.

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¹The writer has collected a bibliography of 187 references. This will be furnished to any one particularly interested in a study of the condition.