Strangled Diaphragmatic Hernia with Gangrene and Perforation of the Stomach*

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Incarceration of stomach in a diaphragmatic hernia with or without simultaneous inclusion of bowel usually signals a surgical emergency. Symptoms of pain, vomiting and occasionally bleeding, together with roentgenographic studies should lead to easy recognition and appropriate surgical therapy. Rarely, strangulation occurs early; then the above symptoms may be overshadowed by the rapid onset of shock.

Incarceration with acute gastric dilatation may produce serious derangement of cardiopulmonary physiology. The superficial resemblance of the clinical and roentgenographic findings to tension pneumothorax may lead the unwary surgeon to institute improper therapy. The correct diagnosis, if suspected, can almost always be readily confirmed roentgenographically after the passage of a stiff stomach tube with or without the instillation of barium. After preliminary decompression of the stomach in this manner, immediate thoracotomy should be performed to complete the relief of respiratory and circulatory embarrassment and to avert the onset of strangulation with possible gangrene and rupture of the stomach.

Incarceration

The following two case reports illustrate the clinical picture of incarcerated stomach with acute gastric dilatation.

CASE 1: A 22 year old colored man was admitted on transfer to McGuire Veterans Hospital on October 31, 1955 on the Orthopedic Service. Four days previously he had sustained a fractured odontoid process and a steering wheel injury to the chest with fractures of the sixth and seventh left ribs. The head was suspended in traction.

On admission the blood pressure was 150/90, pulse 90, respirations 22. The left chest expanded poorly and was hyperresonant. The heart and trachea were shifted to the right. Breath sounds were absent over the left side of the chest; an occasional tinkle could be heard. The clinical findings together with the appearance of the chest roentgenogram suggested a tension pneumothorax to the examining physician (Figure 1). Accordingly, a No. 16 catheter was inserted through a trocar into the second intercostal space anteriorly. A large amount of air and approximately 300 cubic centimeters of greenish fluid escaped, which was identified as gastric contents. After passage of a Levine tube and injection of lipiodol it was recognized that the stomach was present above the diaphragm. The suspicion of a ruptured diaphragm with incarcerated, dilated stomach was immediately confirmed. Thoracotomy was delayed because of the odontoid fracture. Barium studies showed that neither small nor large bowel was contained in the hernia. Drainage from the intercostal tube ceased within a week and the tube was subsequently removed. The patient was able to take a satisfactory oral diet. He suffered one subsequent period of temporary obstruction of the intrathoracic stomach which was relieved by Levine tube. Repair of the diaphragmatic hernia was performed on March 30, 1956 at which time almost the entire stomach with omentum was found in the left pleural space. No scar could be found on the gastric wall to indicate the site of previous intubation. The diaphragm had ruptured from the dome through into the hiatal orifice. Repair was easily accomplished and convalescence proceeded without complication.

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In this case tension pneumothorax was erroneously assumed to have resulted from the fractured ribs and cursory examination of the chest roentgenogram did, indeed, suggest this. Subsequent review of the film, however, revealed the absence of lung collapsed against the mediastinum and the presence of lung compressed into the apex of the left hemithorax. Whenever these findings are encountered a Levine tube should be inserted to localize the stomach. Under usual circumstances immediate or early external decompression was selected. If, however, there is reason to believe that ineffective external decompression may result either in delayed paralysis due to pressure of the mediastinum or to damage to other structures within the thoracic cavity, operation should be resorted to.

FIGURE 1 (Case 1): Chest film shows large air space (dilated stomach) in left hemithorax with lung compressed into the apex and mediastinum shifted far to the right.

FIGURE 2 (Case 2): Acute dilatation in incarcerated gastric hernia identified by lipiodol swallow. FIGURE 3 (Case 2): Partial relief of cardiopulmonary derangement by Devine tube intubation.
surgery should be performed, but in this instance decompression of the stomach by
an unorthodox route averted any serious complication and obstruction of the stomach
was temporarily relieved.

CASE 2: A 37 year old colored man received a knife wound of the mid-axillary
portion of the left lower thorax and a laceration of the occipital scalp on Septem-

During October 1955 he was troubled by intermittent episodes of cramping, epiga-
stric pain, nausea and vomiting. He was thought to have a peptic ulcer, and a bland
diet and various medications were prescribed. He did not follow his physician's advice
to have a barium study of the gastrointestinal tract.

On October 31, 1955 he experienced a severe episode of cramping, epigastric pain,
nausea and vomiting. On the following day he developed severe dyspnea and a mild,
intermittent, non-productive cough; he sought admission to St. Philip Hospital.

Physical examination revealed a blood pressure of 100 systolic, pulse 120, respira-
tions 22, temperature 98.6°F. He was in acute distress, with labored respirations and
mild intermittent cough. The trachea was deviated slightly to the right. The entire
left chest, particularly the left lower portion, exhibited hyperresonance and decreased
breath sounds. There were scattered rhonchi and wheezes in the left upper lung
field. The right lung was clear. The apical cardiac impulse was displaced toward the
right. There was voluntary spasm of the abdomen without tenderness, particularly
in the left upper quadrant. Bowel sounds were hypoactive and were not audible over
the left thorax.

A roentgenogram showed air in the left lower chest with compression of the left
lung into the apex. The mediastinum and heart were shifted markedly to the right.
A lipiodol study demonstrated that the air space represented dilated stomach ex-
tending into the left hemithorax to the level of the third rib posteriorly (Figure 2).
Attempts to pass a standard Levine tube into the stomach for deflation were not
successful because of obstruction at the cardia, but a Devine tube was finally passed
and the stomach partially decompressed (Figure 3).

At thoracotomy a six centimeter defect was found in the left lateral diaphragm.
Most of the stomach and a considerable portion of the transverse colon were her-
niated into the left pleural cavity through this defect. Neither the stomach nor colon
showed any evidence of strangulation. Repair was easily achieved and recovery took
place uneventfully.

Strangulation

Of far more serious import are those cases of incarcerated gastric
hernia which proceed to strangulation. We have observed two cases of
strangulated stomach with rupture which presented many puzzling
features and which are reported here for the first time.

CASE 3: A 33 year old colored woman was admitted to St. Philip Hospital on
September 18, 1946. Hysterectomy for uterine fibrosis was advised. For two years
she had complained of a dull, dragging sensation in the lower abdomen and pelvic
region. A history of vague epigastric pain was also obtained. Nine years previously
laparotomy with bilateral salpingectomy had been performed for ruptured ectopic
pregnancy.

The general physical examination prior to surgery showed nothing abnormal except
a systolic murmur at the apex.

Total hysterectomy and appendectomy were performed on September 20. Post-
operatively she experienced some nausea and vomiting and complained of a moderate
degree of abdominal pain. Her condition, however, remained satisfactory until the
third postoperative evening when she was found in a state of profound shock. The
blood pressure was unobtainable and her pulse was rapid and feeble. Breath sounds
were absent over the left side of the chest and the percussion note was tympanitic
anteriorly and dull posteriorly. A roentgenogram of the chest made with the patient
in the supine position revealed the heart and mediastinum displaced markedly to
the right with a diffuse basiness over the entire left side of the thorax (Figure 4).
A small air pocket overlay the central portion of the left side of the chest. The left
diaphragm was not clearly outlined but appeared to be depressed. A consultant sug-
gested the possibility of a spontaneous hemopneumothorax. Aspiration of the left
side of the chest yielded 200 cubic centimeters of air and 800 cubic centimeters of a
reddish brown, clear, nonodorous fluid. A smear of this fluid was negative, but cul-
tures grew out staphylococcus aureus, alpha hemolytic streptococcus and diphthe-
roids. The acidity of the fluid was not determined. Transfusions of 500 cubic centi-
meters of blood and 500 cubic centimeters of plasma sufficed to correct the hypo-
tension.

During the succeeding days she remained critically ill and exhibited signs of ex-
treme toxicity with the pulse ranging around 140. The temperature varied between
100 and 103° F. The white blood count rose steeply to 30,000. On the fourth day after the acute episode the patient appeared icteric and the icteric index was found
to be 55. The liver was percussed four fingerbreadths below the costal margin.
Daily aspirations of the empyema yielded varying quantities of a brownish-yellow, foul-smelling fluid up to 1000 cubic centimeters, always with some air. One week after the acute episode intercostal catheter drainage was instituted. At this time a consultant postulated the presence of a strangulated diaphragmatic hernia and suggested a barium swallow to demonstrate a gastrophleural fistula. Unfortunately the barium failed to enter the pleural cavity and the radiologist reported that the stomach was beneath the diaphragm. Her condition deteriorated rapidly with serum non-protein nitrogen rising to 336. Shortly before death, lipiodol administered to the patient in the Trendelenburg position passed into the stomach and pleural cavity (Figure 5).

Postmortem examination revealed the fundus of the stomach with most of the greater curvature and six centimeters of the splenic flexure of the colon herniated through a three centimeter defect in the tendinous portion of the left diaphragmatic leaflet, seven centimeters lateral to the esophageal hiatus. We have classified this as a Foramen of Bochdalek hernia. The wall of the herniated colon was intact but there was a four centimeter perforation at the apex of the fundus of the stomach with black gastric mucosa presenting (Figure 6). The left lung was collapsed. Microscopic study showed that the stomach wall and colon were covered by a definite membrane consisting of both diaphragmatic pleura and peritoneum and identifiable as hernia sac.

**CASE 4:** A 19 year old white man was admitted to the Mississippi State Sanatorium December 30, 1950. While playing basketball two months previously he had received a blow in the left side. The resulting pain gradually subsided during the next two weeks. On December 18 he developed a lower respiratory infection with fever, cough and hemoptysis. On December 25 he began to have pain in his left posterior chest which radiated to the epigastrium. Pain, gaseous distention, dyspnea and vomiting followed. A chest x-ray film on December 28 showed collapsed left lung with tension pneumothorax. Several thoracenteses yielded large quantities of air and serosanguineous fluid. On December 30 the pain below the rib margin increased and he went into shock.

On admission to the hospital examination revealed a thin, dehydrated, semicomatose man in critical condition with a temperature of 101.6°F, respirations 36, blood pressure 110/90. The left side of the chest was tympanic and breath sounds were absent. The trachea and heart were shifted to the right. The abdomen was distended, tympanic and tender throughout with no audible peristalsis. On admission the white blood count was 8,900 and this rose rapidly to 48,000. A catheter was inserted into the second anterior interspace for deflation of the pneumothorax. A

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**FIGURE 4** (Case 3): Portable chest film with patient in supine position shows diffuse haziness of entire left thorax with a small air pocket centrally located. Heart displaced to right. **FIGURE 5** (Case 3): Demonstration of gastrophleural fistula by lipiodol.
Levine tube was passed into the stomach but the patient continued to vomit small amounts of fluid. During the next 72 hours he received over 15,000 cubic centimeters of fluid including three pints of blood.

Chest x-ray films on January 2, 1951 showed that the lungs were somewhat better expanded although dense shadows persisted in the lower chest. Fluid aspirated from the chest at this time contained 10 degrees of total acid while that from the gastric tube contained 8 degrees. Lipiodol studies identified the stomach above the diaphragm and disclosed the intercostal tube in communication with the pneumothorax cavity.

His condition gradually improved. However, on January 8 the Wagensteen apparatus for gastric suction was inadvertently reversed forcing a large quantity of air into the stomach. He immediately complained of severe abdominal pain. Immediate thoracotomy revealed an 8 centimeter rent through the dome of the diaphragm through which omentum, spleen and dilated stomach had herniated. After the lower lobe of the lung had been dissected free and large amounts of thick fibrinous exudate removed, two large holes were found in the anterior wall of the stomach measuring approximately 2 by 1.5 centimeters and 1 centimeter in diameter respectively. A third, larger hole near the cardioesophageal junction was apparently due to pressure necrosis from the acute angulation against the edge of the intact hiatus. The gangrenous portions were excised and the rents closed. The intrathoracic mass was reduced with difficulty even after enlarging the diaphragmatic rent. The diaphragm was then repaired. Because of his condition no attempt was made at this time to decorticate the lung.

The patient's condition remained critical with persisting peritonitis and empyema and with a bronchopleural fistula. On January 20, 1951 a Stamm gastrostomy was performed and a feeding tube passed through the pylorus into the duodenum. After three weeks he began taking fluids orally which initiated drainage through his thoracotomy tube. Methylene blue confirmed the presence of a cardioesophageal fistula which closed prior to his discharge on June 27, 1951. At that time a drainage tube remained in the empyema cavity.

Ultimately, on November 17, 1953, a Schede thoracoplasty was required to close the bronchopleural fistula.

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FIGURE 6 (Case 3): Four centimeter perforation in fundus of strangulated stomach. Lung collapsed.
This case illustrates again the error of confusing a dilated stomach with tension pneumothorax. The hernia which did not have a sac and was thought to be traumatic, probably resulted from the basketball injury two months prior to the onset of acute symptoms. Coughing from the respiratory infection may have increased the incarceration to the point of obstruction. It is likely that the perforation at the cardioesophageal junction had occurred just prior to admission, resulting in generalized peritonitis. Bernatz,14 in reporting the experience from the Mayo Clinic mentions having seen perforation of the esophagogastric junction "where the stomach turned abruptly around an intact esophageal hiatus into the thorax." The perforation in the upper stomach also must have occurred during the early period, only to be sealed off by the adherent lung, until the episode of forced overinflation.

In 1948 Harrington1 wrote, "I have never seen a stomach which was strangulated as a result of hernia, nor do I believe that it is possible because of the powerful musculature and rich blood supply in the gastric wall." However, a number of surgeons have reported finding congestion, edema and discoloration in the wall of a stomach incarcerated in a diaphragmatic hernia. This may proceed to complete loss of viability as attested to by 17 previous cases of gangrene or perforation of the herniated stomach observed at surgery or autopsy.15-17

A review of these cases together with our own has yielded the following information. In 10 of the 19 cases the diaphragmatic hernia was traumatic in origin. In the nine nontraumatic cases the herniation was para hiatal in five, hiatal in two, and through a Foramen of Bochdalek defect in two. Only two were through the right leaf of the diaphragm. The two which we have classified as hiatal are probably a combination of para hiatal and hiatal since almost the entire stomach was herniated through the opening. Nonstrangulated large and small bowel in one case and large bowel in a second case were present in the hernia together with strangulated stomach. In 10 cases thoracentesis had been performed prior to surgery and in all of these sanguineous fluid was obtained. In several the fluid was recognized as gastric and wastested for acidity.

FIGURE 7 (Case 4): X-ray made January 2, 1950 demonstrating tube and injected lipiodol in supradiaphragmatic stomach. Note the thoracotomy tube which is in the free pleural cavity superiorly.
In others the fluid may have represented sanguineous pleural fluid. The fluid may have represented sanguineous pleural fluid.

In at least six of the 19 cases gangrene occurred within 48 hours or less from the time of onset of symptoms. In other patients a number of days elapsed before surgery was undertaken so the rapidity with which gangrene developed is not known. In four instances the diagnosis was not even suspected until thoracotomy. In five the diagnosis was first determined at autopsy. Of 14 which were operated upon with resection of part or all of the stomach seven died and seven recovered.

In a review of 150 cases of volvulus of the stomach, most of which were unassociated with diaphragmatic hernia, Dalgaard found 15 cases of perforation or gangrene at surgery or autopsy. However, in the cases of gangrene of the stomach occurring as a direct result of diaphragmatic herniation which we have reviewed no case of frank volvulus was found. However, minor degrees of torsion can certainly not be ruled out, particularly in those hernias of the parahiatal type.

Incarcerated diaphragmatic hernias proceeding to strangulation have been reported during pregnancy or labor or have resulted from other causes of increased abdominal pressure, such as vomiting, physical exertion, overeating and postoperative distention. Possible etiologic factors in our case 3 were: the steep Trendelenburg position employed during surgery and increased intraabdominal pressure resulting from postoperative vomiting and ileus. Pain was absent as an important symptom although it may have been somewhat overlooked in the postoperative period. The profound state of shock which this patient exhibited signaled the rapid onset of strangulation. The correct diagnosis might have been entertained if a roentgenogram could have been made with the patient in the upright position. The hemorrhagic fluid aspirated from the chest was not tested for acid but in retrospect suggested gastric contents. A virulent empyema developed after perforation of the stomach, which caused a toxic nephritis, and after drainage of the empyema a large volume of intestinal juices was lost through the thoracogastric fistula. Failure to confirm radiologically the subsequent suspicion of perforated diaphragmatic hernia led to further costly delay.

Symptoms to be expected with strangulated gastric hernia include those seen in acute incarceration with the addition of circulatory collapse. Usually there is a sudden onset of severe pain in the left upper quadrant, epigastrium or lower left chest regions. Vomiting often occurs but is ineffectual and usually without evidence of blood, even though strangulation is present, because of obstruction at the hernial orifice. Left shoulder pain and hiccupping, though observed infrequently, are important symptoms when present. Owing to displacement of the heart and lungs respiratory embarrassment, cyanosis, tachycardia and hypotension are commonly observed. Extravasation of bloody fluid contributes to the state of shock. Local signs over the chest include dullness or tympany, absent breath sounds and occasionally splashing and sucking sounds. Examination of the abdomen is negative unless bowel is also included in the hernia, in which case evidence of intestinal obstruction is usually found.
Roentgenographic findings should permit the correct diagnosis in the majority of cases. In a few cases, as in our case 4, a large pneumostomach may be present and can be confused with tension pneumothorax or with hemopneumothorax. However, collapsed lung is not seen against the mediastinum but is found compressed into the apex of the hemithorax. With less distention of the stomach the diaphragm may appear to be high, whereas the upper margin of opacity really represents the superior border of the stomach. Indeed, the herniated organ may be hidden behind the heart shadow. An upright chest x-ray film may reveal the presence of a gas bubble which is helpful in localizing the stomach. The heart is shifted toward the right, an important observation, since the fluid in the thorax is insufficient to cause this degree of displacement. After passage of a stiff gastric tube, implemented, if necessary, with lipiodol or barium instillation, the stomach can usually be localized above the diaphragm. However, because of obstruction at the hernial ring, it is not to be assumed that either the stomach tube or contrast medium will invariably find its way into the herniated portion of the stomach, and indeed the passage of a tube through the cardia may occasionally prove impossible in the presence of torsion or pressure upon the cardia by the distended stomach.

Pleural effusion resulting from primary lung or subdiaphragmatic pathology may occasionally require differentiation, but should not present the acute clinical picture seen in strangulated hernia.

Because of rapid deterioration from strangulated gastric hernia immediate surgery employing a thoracotomy approach is certainly indicated. If gangrene or perforation of the stomach is encountered, localized resection of the involved stomach with reestablishment of the gastric continuity is the procedure of choice. Compromising measures of lesser magnitude are unlikely to succeed. The empyema resulting from gastric perforation and the thoracogastric fistula produced by drainage of an empyema create enormous problems in the management of the patient. Subsequent surgery will have to be carried out on a greatly depleted patient in the presence of collapsed lung needing decortication.

**SUMMARY**

1. Seventeen cases of strangulated diaphragmatic hernia with gangrene and perforation of the stomach have been reviewed from the literature and two additional cases reported.
2. The clinical picture is described in detail.
3. Two cases of incarceration of the stomach with acute gastric dilatation are described to emphasize the ease with which a cursory examination may lead to the erroneous diagnosis of tension pneumothorax.
4. We have stressed the urgency of immediate surgery to avoid the complication of strangulation and possible perforation.

**RESUMEN**

1. Se han revisado 17 casos de hernia diafragmática estrangulada con gangrena y perforación del estómago según la literatura y se relatan dos casos más.
2. Se describe el cuadro clínico en detalle.
3. Dos casos de encarcelación del estómago con dilatación aguda gástrica se describen para recalcar la facilidad con que un examen corriente puede conducir al diagnóstico erróneo de neumotórax hipertensivo.
4. Hemos hecho notar la urgencia de la cirugía inmediata para evitar la complicación de la estrangulación.

**RESUMÉ**

1. 17 cas de hernie diaphragmatique étranglée avec gangrène et perforation de l'estomac signalés dans la littérature sont étudiés par les auteurs qui rapportent deux cas supplémentaires.
Le tableau clinique est exposé en détail.

3. Deux cas d’incarcération de l’estomac avec dilatation gastrique aiguë sont décrits. Ils permettent de mettre l’accent sur la facilité avec laquelle un examen superficiel peut amener au diagnostic erroné de pneumothorax sous tension.

4. Les auteurs insistent sur l’urgence d’un acte chirurgical immédiat pour éviter la complication possible d’extrémité et de perforation.

**ZUSAMMENFASSUNG**


2. Das klinische Bild wird im einzelnen beschrieben.


**REFERENCES**


