Traumatic Closed Rupture of the Diaphragm*

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In 1959, some of us described a case of diaphragmatic hernia, with strangulation and gangrene of the stomach due to an open wound. In the present study, we refer to diaphragmatic hernia resulting from indirect trauma and especially avulsion of the diaphragm.

This subject acquires more and more interest because traffic and other accidents of modern life have increased the number of severe thoracoabdominal crushings.

In such patients, our attention should not concentrate only on injuries of the skeleton and abdominal viscera. A thorough search for the detection of initial clinical and radiologic signs of a ruptured diaphragm is essential, in order to make an early diagnosis and avoid complications. Early diagnosis and operation are noted in only one-third of a worldwide collection of ruptured diaphragms after a nonpenetrating injury.

We thought, therefore, it interesting to present three cases recognized in time; two of them presented an avulsion of the diaphragm and one a large rupture. The avulsion of sternocostal insertions of the diaphragm is rare and is described for the first time in the Hellenic literature. On this occasion, we thought it opportune also to present a case of strangulated hiatus hernia which resulted in the early postoperative period, from a transthoracic Heller’s esophagomyotomy, because, both after a non-penetrating trauma of the trunk and an operation which did not include an incision on the diaphragm, the surgeon’s attention is not directed immediately to the possibility of a traumatic diaphragmatic hernia.

Case Reports

Case 1

This quarry-man, aged 43, was crushed by a falling rock. He lost consciousness for a while and was transferred to the hospital in shock. Fractures of the ribs and lateral processes of the lumbar vertebrae were found. Next morning, his general condition was better, but a resistance, as well as paradoxic respiratory motion of the epigastrium were noted. The base of the left hemithorax showed tympany and decreased breath sounds. An x-ray film of the chest showed besides the ruptured ribs, a small shift of the mediastinum to the right and in the left hemithorax two radiolucent areas in the form of the stomach and left colic flexure. The diagnosis of traumatic diaphragmatic hernia was established during the next few days by a barium study (Fig. 1). His condition was good and a transthoracic operation was performed within ten days after the accident. The stomach, omentum, spleen, colon and coils of small intestine were found in the chest, as well as 500 ml. of blood. Thin adhesions of the bowels to the lung and the ruptured diaphragm were freed. The insertion of the diaphragm was found avulsed from the sternum of the tenth rib. The phrenic nerve was crushed in order to secure the suture of the avulsed diaphragm to the intercostal muscles. Thick U silk sutures were employed and an underwater drainage was instituted.

The postoperative period was smooth and final radiologic findings satisfactory.

Case 2

This driver, aged 44, was crushed on the steering wheel of a truck after a traffic accident. He was transferred unconscious to a provincial hospital. Next morning he recovered consciousness, but was short of breath and had a spasm of the muscles of the abdominal wall. The surgeon in charge advised an exploratory laparotomy, but he and his relatives refused operation. During next week, he was better, but had melena. He also complained of nausea, vomiting and a sensation of "something dripping within his chest when he drank liquid."

A shadow on the base of the left hemithorax was verified and the relatives decided to transfer the patient to the Hippokration Hospital in Athens. On examination he was short of breath and in moderate shock. Hematocrit was 28.

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Tympany and dullness were found over the base of the left hemithorax. An x-ray film of the chest showed a shadow at the left base and some small radiolucent areas in it.

The diagnosis of rupture of the diaphragm was verified by a barium swallow which demonstrated a supradiaphragmatic stomach in volvulus (Fig. 2).

A transthoracic approach confirmed the presence of the stomach, transverse colon and loops of small intestine. Thin adhesions to the lung, pleura and diaphragm were freed. After the reduction of the abdominal viscera, an avulsion of the diaphragm was found, extending from the sternum to the anterior axillary line.

It was only after the phrenic nerve was crushed that the avulsed diaphragm could be sutured to the antero-lateral chest wall by strong U silk sutures without tension. Underwater drainage was instituted and the chest closed.

The postoperative course was uneventful. An acromioclavicular dislocation, made evident at this time, was corrected. A final radiologic check-up examination proved satisfactory.

**CASE 3**

This workman, aged 32, was crushed under a fallen mechanical digger. He lost consciousness temporarily and was transferred to the hospital after a few hours in moderate shock. He presented paraplegia due to a fracture-dislocation of L1 vertebra. Fractures of the lower ribs on the left were clinically evident.

Next day, the reduced respiratory excursion of the left hypochondrium, with a sensibility of the epigastrium and diminished breath sounds over the left base, lead to an x-ray film of the chest with a portable unit, with the patient in the semisitting position. An intrathoracic pear-like cavity and a mediastinal shift established the diagnosis of rupture of the left diaphragm (Fig. 3). His general condition was deteriorating, and there was no other choice but operation. Low left thoracotomy was chosen. The spleen, stomach, omentum, small intestine and colon were found within the chest. The rupture of the diaphragm extended from the anterior axillary line of the left hypochondriuim, by the fractured ribs, to the left crus of the diaphragm without involving it. The diaphragmatic tear was sutured without difficulties. Underwater drainage was instituted and the chest closed. About the middle of the operation the patient's condition deteriorated.

He succumbed within four hours after the end of the operation. Necropsy verified a big retroperitoneal hematoma, a small quantity of blood in the abdominal cavity, several small ruptures of the superior surface of the right lobe of the liver and a fractured pelvis.

**CASE 4**

This farmer, aged 52, was operated for mega-esophagus by the transthoracic route. A typical Heller's esophagomyotomy was performed after mobilization of the infradiaphragmatic esophagus.

The next few days after the operation, x-ray films showed a shadow in the left base of the chest which was explained as a localized hydro pneumothorax. Clinically, signs of fluid were found in the chest.

On the sixth postoperative day, he complained of intense pain in the left chest and had the
FIGURE 3: Dilated stomach herniated in the left hemithorax. Shadows of other herniated organs on the left.

"Same difficulties in swallowing as before the operation." New radiograms showed again a fluid and air level. The contour of the upper end of the radiolucency was not particularly noticed. Thoracentesis produced a milky, pinkish fluid. The possibility of a chylothorax was considered. Another radiologic examination next morning demonstrated a big radiolucent spheric area situated highly. Unlikely as it might have seemed, the fluid aspirated from the chest, was real milk. A barium swallow proved it beyond any doubt (Fig. 4).

By then he complained of "something dragging his stomach." Spasm of the right epigastrium was found. A Levin tube could not be passed to the stomach. Strangulation was already established.

An approach through the epigastrium did not allow the reduction of the stomach which was almost totally herniated, and the incision was extended to the thorax. The stomach was cyanotic and distended. It was only after aspiration that it could be shifted back to the abdomen. The size of the esophageal hiatus was reduced by one suture and the cardia and greater curvature of the stomach were fixed carefully to the diaphragm. Decortication of the base of the lung was found necessary in order to expand the lung. Underwater drainage was instituted and the incision was closed.

The patient had postoperatively suppuration of the incision and localized empyema was formed. Several aspirations aided by the injection of antibiotics succeeded in obtaining full expansion of the lung. A final check of the esophagus and stomach was satisfactory.

DISCUSSION

Our first three patients are men of middle age, exposed to occupational hazards which caused the rupture. The fourth case demonstrates that after mobilization of the esophagus in order to perform vagotomy or esophagomyotomy, meticulous care should be taken in order to reduce the size of the hiatus and fix the stomach.

Avulsion of the diaphragm is a rare occurrence as it is shown in two large statistics. Moreaux\(^1\) found 22 cases among

FIGURE 4: Hourglass constriction of the herniated stomach. The tapered shadow up on the left is the lower end of the megaesophagus. The lower shadow is the pouch near the cardia. The radiolucent spheric area up on the right, with some barium at its bottom, is the strangulated portion of the stomach.
349 ruptures of the diaphragm in the international literature: Bernatz, Burnside and Clagett reported eight cases among 112 diaphragmatic hernias. Occasional cases have been reported since by others.44

The mechanism of rupture in our cases was evidently a compression of the thorax or the abdomen or both. A violent forward flexion of the body is a possible mechanism in Case 3.

Compression of the abdomen on the steering wheel and a transference of considerable force by gas-containing organs to the diaphragm occurred in Case 2, without any fracture of ribs.

All ruptures in our series concern the left hemi-diaphragm as do most larger series. This is perhaps explained by the presence of the liver which resists and distributes the pressure. The tamponading effect of the liver is possibly demonstrated by the small ruptures on the dome of the liver in Case 3.

Injuries of the skeleton are commonly found together with rupture of the diaphragm.55 Ruptures of abdominal viscera however, are not so common.44,45

Dislocation of abdominal organs into the thorax is due to the increased intra-abdominal pressure and the negative intrathoracic pressure. Case 4 demonstrates how these two factors can result in a large herniation of the stomach in a very short time, in spite of the smallness of the hiatus and its almost complete filling by the esophagus.

Diagnosis: Thoracoabdominal contusion with or without fractured ribs should always raise the question of possible coexistence of a ruptured diaphragm, especially if there are shadows or increased translucencies at the base of the lung. Displacement of various abdominal viscera into the chest may simulate, on the standard chest film, several other conditions.

Mistakes can be made when the standard films are taken by portable unit. We avoid taking them in recumbent position, and if necessary, lateral recumbency is chosen. Lateral views are never omitted.

We prefer penetrating x-rays of the chest (Fig. 3). We also insist on repeating films so that a late herniation is not missed.

The clinical signs both local from the chest and general from the circulatory and respiratory systems are better evaluated with a high index of suspicion on every case of closed traumatism of the chest or abdomen. Findings relative to the epigastrium as, emptiness, tenderness, spasm or paradoxic respiratory motion should point to diaphragmatic injury.

Exploratory thoracentesis is sometimes employed. All sorts of fluids or air may be obtained according to the site of the needle, the herniation of viscera or the special situations encountered on each occasion. The real problem is to avoid interpreting the findings incorrectly. Diagnoses of pneumothorax, empyema or gaseous cyst can be made and an underwater drainage decided upon.44,45 We had personal experience as to how easy it is to be mistaken in Case 4.

In acute conditions, the diagnosis can be confirmed by the patient swallowing a Levin tube. If it reaches the herniated stomach, it is easily detected within the chest by a simple radiograph. This preoperative measure can also be helpful in reducing the mediastinal shift. If this procedure fails and there is severe respiratory disturbance, decompression of the stomach may sometimes be effected by aspiration through a needle. This is permissible only when the diagnosis is certain and the patient must be alleviated of mediastinal shift in order to be operated immediately thereafter.3

The study by contrast medium taken by mouth or given by enema, offers more thorough exploration, if the patient's condition permits it (Figs. 1, 2 and 4).

Several complications may follow, if the diagnosis is missed: high or low obstruction, strangulation and necrosis of the bowels or the stomach, perforation of an ulcer either acute or preexisting.13 Hematemesis or melena may be a sign of strangulation, but can occur without it as in Case
2, because of bleeding, acute ulcers or stress hemorrhagic gastritis.13

Treatment. Early diagnosis and operation are of utmost importance if complications are to be avoided. On the other hand, viscera remaining long within the thorax lose their site in the abdomen. Adhesions may form and the tear of the diaphragm is stabilized, so that in late operation plastic procedures have to be employed in order to fill the gap. Early operation, however, should be properly timed. Very often one has to deal with a severe shock. If the mediastinal shift is not important, and no elements of intra-abdominal hemorrhage exist, shock is due to the injury itself or a known loss of blood. Under such circumstances, the conservative treatment by blood transfusions and other measures is indicated. Difficulty in breathing can be ameliorated by artificial respiration.

In case, however, the mediastinal shift is important, it should be corrected before operation.

If an abdominal tap shows a quantity of pure blood, an abdominal exploration is mandatory.

Nevertheless there are cases which put the surgeon on the horns of a dilemma. A delay proves often to be in favor of the patient, as shock may subside on conservative regimen, but there have been cases which deteriorated because of early strangulation, respiratory difficulties or occult internal hemorrhage. On the other hand, an operation judged necessary may prove fatal. Case 3 presented such difficulties in operative decision.

The thoracic approach proved very useful in our two cases of avulsion, because suture was easier than if undertaken through the abdomen. In our third case, the thoracic approach had two disadvantages: (a) it did not allow adequate exploration of the entire upper surface of the liver, (b) it was more aggravating to the patient with severe skeletal injury and retroperitoneal hematoma. In Case 4, the abdominal approach, elected because of a recent thoracotomy, proved inadequate and it was found necessary to extend it to the thorax.

Several writers prefer the abdominal approach which allows a better exploration of all abdominal viscera and both leaves of the diaphragm. Taking into consideration that ruptures of abdominal viscera are more common and dangerous than of intrathoracic organs, after severe crushing of the trunk, the abdominal approach is preferable when the patient is operated upon immediately after injury, although the suture of the diaphragm may prove more difficult. When, however, the patient is operated upon later with an indication concerning diaphragmatic hernia or its complications, the thoracic route is preferable. It allows full control and liberation of herniated viscera, complete expansion of the lung and an easy and safe suture of the rupture of the diaphragm independently of its location and type.

The suture of the avulsion is a special problem. We have employed thick silk U sutures deeply through the intercostal spaces. Perry, Francis and Lonergan4 used reinforcing sutures around the ribs.

We performed, however, phrenic nerve crushing to avoid recurrence despite disadvantages on respiration and expectoration. No pulmonary complications occurred.

Another alternative for avoiding undue tension is to suture the avulsed lip to a higher intercostal space and if necessary, a limited thoracoplasty of the lower ribs may be employed as required.14

Summary and Conclusions

1. Four cases of traumatic diaphragmatic hernia are described. Three of them were the result of nonpenetrating injury. The fourth with strangulation of the stomach, followed an esophagomyotomy. Two cases had a large avulsion of the sternalcostal insertion of the diaphragm.

2. Fracture of the ribs is not a prerequisite for a rupture of the diaphragm, but often coexists as do other fractures of the skeleton.
3. Rupture of the diaphragm should be suspected after an injury of the trunk or an operation on the diaphragm on the basis of clinical or radiological data relative to either chest or epigastrium.

4. Early diagnosis is desirable and preoperative correction of shock and mediastinal shift is essential. The timing of operation is sometimes a dilemma.

RESUMEN

1. Se describen cuatro casos de hernias diafragmáticas traumáticas. Tres fueron consecuencia de lesión cerrada. La cuarta fue una estrangulación después de una esofagiomiotomía. En dos hubo una amplia avulsión de las inserciones esternocostales del diafragma.

2. Las fracturas de las costillas no preceden necesariamente a la ruptura del diafragma, pero a menudo coexisten, así como otras fracturas del esqueleto.

3. La ruptura del diafragma es de sospechar después de un trauma del tronco o de una operación del diafragma en caso de datos clínicos o radiológicos por parte del tórax o del epigastrio.

4. Es deseable un diagnóstico inmediato y la corrección prequirúrgica del shock y de la desvación del mediastino. El momento de la operación es a veces un dilemma.

REFERENCES


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