Right Diaphragmatic Hernia Secondary to Trauma

With Report of Two Cases

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• **With automobile accidents at high speed on the increase, some previously rare injuries are becoming more common. Rupture of the left diaphragm is fairly common. On the right, it has been believed rare. The diagnosis has often been missed for many years after the causative injury.**

Any suspicious x-ray film shadow at the base of the right lung field after injury such as those that occur in accidents of great impact should arouse the physician's suspicions. A mushroom-shaped mass on the lateral x-ray view is characteristic.

Introduction of pneumoperitoneum may help in diagnosis. Only if the peritoneal and pleural cavities communicate will this procedure produce a pneumothorax.

Surgical correction is indicated in all cases. This is best done through the chest. The right lobe of the liver usually must be reduced. In general the results are excellent.

TRAUMATIC DIAPHRAGMATIC HERNIAS are being reported in increasing number. This is due to several factors. Automobile accidents at high speeds have resulted in more cases of severe multiple injuries, and nowadays more patients survive as a result of advancing knowledge in the early treatment in such cases. Entities such as traumatic diaphragmatic hernias, once considered rarities, are now being recognized and successfully treated. Gradually, the pathological patterns associated with these injuries are becoming evident.

Since strangulated diaphragmatic hernia is of traumatic origin (Carter[2]) in some 90 per cent of cases, it is a condition to be kept in mind in dealing with persons who have been injured in ways that might cause the diaphragm to rupture. From 95 to 98 per cent of traumatic diaphragmatic hernias occur on the left side.[7] The liver tends to protect the right diaphragm from rupture. When the right diaphragm is ruptured, however, the rent may be a very large one, permitting the liver to become tamponaded in the opening or part of the liver and part of the bowel to rise into the pleural cavity.

It is important that repair be done early in cases in which the liver is involved. In the case reported by Child[4] the injury had taken place 44 years previously and it was necessary to amputate that portion of the liver above the diaphragm which had become elongated and could no longer be easily replaced. Protrusion of the liver into the thorax can considerably impair cardiovascular function. The liver mass constricts and may interfere with its own blood supply, causing early strangulation of the liver substance and bringing about pain or distress in the right upper quadrant and subcostal areas.

In many cases, pneumothorax may follow laparotomy. For this reason an endotracheal tube should always be used in any laparotomy following a massive crush injury. An unsuspected diaphragmatic opening would result in pneumothorax with serious degrees of anoxia if the anesthetist were unprepared to control the intrapulmonary pressure.

Although in most cases the injuries are received in automobile collisions, such causes as falling from a great height,[4] being kicked in the abdomen,[18] an airplane crash,[11] a stab wound[5,13] and a mining accident[20] have been reported as causes. Often the patient has numerous other lesions, particularly multiple fractures of ribs. A few have been reported with no history of previous trauma.

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Diagnosis

There may be no specific symptoms referable to the ruptured diaphragm immediately after the accident, or the examiner's attention may be drawn to other serious injuries. In most of the cases reported in the literature diagnosis was not made until many years after the causative injury. The more common symptoms include pain over the chest and evidence of disturbance of cardio-respiratory function owing to displacement. Dyspnea and cyanosis, tachycardia, lowered blood pressure, mediastinal shift and signs of intestinal obstruction may occur.

In the differential diagnosis, such conditions as emphysema, eventration of the diaphragm, cystic disease of the lung, lung abscess, intrathoracic tumors, pleural effusion, chronic pleurisy and hemothorax must be considered. In many of these conditions, the preoperative diagnosis is merely of academic importance for the preferred treatment is surgical operation.

Carter[2] has divided the course of traumatic diaphragmatic hernia into three separate phases. Dur-

ing the first phase, immediately following the injury, shock and upper abdominal pain, which may radiate to the shoulders, are often present. The lower chest may be dull or tympanitic. The mediastinum may be shifted. During the second phase, the symptoms are frequently vague, suggesting coronary disease, peptic ulcer, gallbladder disease or incomplete intestinal obstruction. The third phase is characterized by obstruction or strangulation of viscera incarcerated in the diaphragmatic opening.

In the relatively rare strangulated right diaphragmatic hernia, symptoms are usually vague and nonspecific.

Roentgen Diagnosis

Barium studies are of help in cases in which the stomach or bowel is involved. Following trauma, any suspicious shadows at the bases of the pleural cavities must be carefully evaluated with the possibility of diaphragmatic hernia in mind. Lateral views may be of assistance. Some investigators[8,19] have found that pneumoperitoneum is sometimes helpful. A characteristic mushroom-shaped mass on the lateral view is outlined by the air in cases in which there is a communication between the peritoneal and pleural cavities; but if no such communication exists, pneumoperitoneum is of no assistance.

Surgical Treatment

Most investigators have expressed preference for the thoracic approach because with the abdominal incision the right lobe of the liver gets in the way. Rives[18] advocated a thoraco-abdominal approach, particularly in cases of long standing with numerous vascular adhesions to the liver. In these cases mobilization of the liver through the chest approach alone may create serious hemorrhage. Manlove,[15] on the basis of observations in a case of bilateral rupture, advocated the abdominal approach.

Opinion differs as to the advisability of crushing the phrenic nerve. Many surgeons recommend it, but unless the repaired diaphragm is under considerable tension the disadvantages would seem to far outweigh the advantages. As Chamberlain[3] pointed out, the three reasons for paralyzing the diaphragm are to quiet the operative field, to bring about maximum relaxation of the diaphragm and thereby facilitate repair, and to promote healing. However, adequate anesthesia will sufficiently quiet the field and relax the diaphragm, and relaxation as a way to promote healing is no longer as generally subscribed to as formerly. The detrimental effects of phrenic paralysis are many and frequently severe. The loss of phrenic function will reduce the patient's respiratory reserve, will diminish the efficiency of normal bronchial peristalsis and of tracheobronchial cleansing by cough. In a fair proportion of cases in which the diaphragm is "temporarily" paralyzed by crushing, it never again functions. In many cases only partial function is regained, for loss of nerve supply causes a lower motor neuron type of atrophy which may never completely reverse. A left phrenic crush often results in gastric disturbances.

Most investigators have expressed belief that it is wise to place tubes for drainage of the field after the operation, since usually it is necessary to free adhesions in the course of the procedure. This causes exudate to accumulate in the thoracic cavity, where it embarrasses reexpansion of the lungs unless it is drawn off. Drainage from tubes in place is far less distressing to most patients than thoracentesis.

Repair of the defect is usually easily done by use of mattress or interrupted heavy nonabsorbable sutures. Should the diaphragm be avulsed from its line of attachment and not enough cuff remaining for resuturing at the normal site of junction, the edge of the avulsed leaf can be attached over one or two interspaces at a higher level.[7] In rare instances it may be necessary to remove small posterior segments of the lowermost ribs. The diaphragmatic extension into the transversalis muscle may be dissected out to obtain closure without tension. When the diaphragm is detached from the chest wall, mattress sutures through the chest may be tied over tubes on the outside. This is followed by interrupted intrapleural sutures.[10]

REPORTS OF CASES

CASE 1. A six-year-old girl was admitted to the San Jose Hospital on December 7, 1956, shortly after she had been struck by a truck. Upon admission she was acutely ill, slightly cyanotic and hyperpneic. The radial pulse was faint and the rate was 160. The systolic blood pressure was 50 mm. of mercury. Extensive pelvic fractures, traumatic evulsion of the urethra and bleeding from the vagina were noted. The right diaphragm was roentgenographically observed to be decidedly elevated, and it was thought then that the displacement might be caused by a subdiaphragmatic accumulation of blood secondary to a hepatic laceration, or by traumatic eventration of the diaphragm or hemothorax. No ribs were fractured. The chest expanded evenly and the lungs were clear to auscultation. Breath sounds were diminished from a point about 1.5 cm. below the nipple line on the right and were almost absent at the right base. In this area the lung field was dull to percussion. The patient complained of generalized abdominal pain. The abdomen was soft, but there were no bowel sounds. Tympany

was present over the entire abdomen, most pronounced in the left upper quadrant.

As the urethral meatus could not be located, extraperitoneal urinary extravasation was considered probable. Ruptures of the diaphragm, the spleen or the liver were considered as possibilities.

Serum albumin and later whole blood were administered and eight hours after admission the general condition of the patient was much improved. She was then taken to surgery for exploratory laparotomy. At thoracentesis on the right just before operation was begun, not more than 80 cc. of blood was removed.

At operation the floor of the urethra was found to be completely torn from the roof of the vagina, permitting continuity between the two canals. The left vaginal vault was severely lacerated. A 2 cm. linear laceration of the right lateral wall of the bladder was repaired. Then the area was drained and suprapubic cystostomy was carried out. Upon exploration of the remainder of the peritoneal cavity, 200 to 300 cc. of serous fluid was found. No evidence of blood was noted even when sponges were placed in the gutters in the region of the liver and spleen. Convalescence was uneventful except that a urinary tract infection developed. The patient was febrile from December 23 onward.

As x-ray films of the chest showed the right diaphragm still elevated, thoracentesis was carried out several times but only a few cubic centimeters of what appeared to be old blood was aspirated. It was therefore believed that an organizing hemothorax was present. Diaphragmatic herniation was considered but was thought to be unlikely in view of the absence of blood in the peritoneal cavity at the previous laparotomy. Bronchial rupture was considered an unlikely possibility.

On January 10, a preliminary bronchoscopic examination showed no evidence of bronchial injury, so exploratory thoracotomy was carried out, the chest being entered through the seventh interspace. The right leaf of the diaphragm was found to be ruptured from a point posteriorly near the diaphragmatic crura, the tear extending over the dome to an anterolateral position several centimeters from the chest wall. The greater portion of the right lobe of the liver lay in the right lower thoracic cavity. Numerous adhesions between the rolled diaphragmatic edges and the liver were readily freed with sharp and blunt dissection. There was no peel on the lung, which expanded immediately without difficulty.

After the liver had been reduced into the abdominal cavity, the diaphragmatic edges were sutured. An intrapleural catheter was inserted before closure and was removed on the second postoperative day. Convalescence was entirely uneventful and subsequent x-ray films showed the diaphragm in normal position and normal lung expansion.

Comment: This case illustrates the diagnostic difficulties that may be encountered. Although strongly suspected, the diaphragmatic defect was not found at the time of the first laparotomy because the liver completely tamponaded the diaphragmatic opening, giving excellent hemostasis to the torn diaphragm.

CASE 2. A 20-year-old white man who was thrown from his car in a collision soon afterward noted sharp pain in the chest, in the right shoulder-strap area and in the right mid-abdomen. He had some dyspnea, which was more pronounced when lying down. He was in hospital from June 9, the day of the accident, until June 13. X-ray films showed pronounced elevation of the right diaphragm. The patient was essentially asymptomatic at the end of this period and was permitted to go home, with the advice that he seek further medical care.

At the time he was first examined by the authors, thoracentesis was carried out on the right side and 120 cc. of sanguinous fluid was withdrawn. X-ray films showed the right diaphragm still elevated. Tympanic dullness over the lower half of the right chest was noted and no motion of the right diaphragm was detected. There were tenderness and swelling of the right costal arch and evidence of a fractured costal cartilage in this area.

With the presumptive diagnosis of traumatic right diaphragmatic hernia, operation was done June 27. A laceration of the diaphragm was observed, extending from a point one inch lateral from the inferior vena cava, across the dome of the diaphragm to within two inches of the lateral chest wall. A large part of the liver had herniated through this defect and this organ was tightly impacted. After the liver was returned to the abdomen, the edges of the defect were approximated with No. 1 and 2-0 silk. Convalescence was entirely uneventful.

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REFERENCES

1. Bliss, R. W., and Green, M. M.: Traumatic rupture of the diaphragm with bilateral pneumothorax, Southwestern Med., 23:367, 1939.

2. Carter, B. N., Guiseffi, J., and Felson, B.: Traumatic diaphragmatic hernia, Am. J. Roentgenol., 65:56, 1951.

3. Chamberlain, J. M., and Ford, J. M.: Diaphragmatic hernias produced by direct violence, S. Clin. North America, 33:1505, 1953.

4. Child, C. G., III, Harmon, G. S., Dotter, C. T., and Steinberg, I.: Liver herniation simulating intrathoracic tumor, J. Thoracic Surg., 21:391, 1951.

5. Dugan, D. J., and Merrill, D. L.: Right phrenohepatic incarceration, Am. J. Surg., 94:208, 1957.

6. Evans, C. J., and Simpson, J. A.: Fifty-seven cases of diaphragmatic hernia and eventration, Thorax., 5:343, 1950.

7. Harrington, S. W.: Esophageal hiatus diaphragmatic hernia, Rocky Mount. M. J., 49:665, 1952.

8. Hollander, A. G., and Dugan, D. J.: Herniation of liver, J. Thoracic Surg., 29:357, 1955.

9. Hollman, F. J.: Bilateral traumatic rupture of the diaphragm, Brit. J. Surg., 1:299, 1940.

10. Hughes, F., Kay, E. B., Meade, R. H., Jr., Hudson, T. R., and Johnson, J.: Traumatic diaphragmatic hernia, J. Thoracic Surg., 17:99, 1948.

11. Keene, C. I., and Copleman, B. T.: Right diaphragmatic hernia, Ann. Surg., 122:191, 1945.

12. Kleitsch, W. P., Munger, A. D., and Johnson, W. F.: Diaphragmatic hernia with complete evisceration of the liver, S. Clin. North America, 30:961, 1950.

13. Knoepp, L. F.: Unusual diaphragmatic hernia with displaced liver, J. Thoracic Surg., 21:394, 1951.

14. Lam, C. R.: Treatment of traumatic hernia of the diaphragm, Arch. Surg., 60:421, 1950.

15. Manlove, C. H., and Baronofsky, I. D.: Traumatic rupture of both leaves of the diaphragm, Surgery, 37:461, 1955.

16. Neal, J. W.: Traumatic right diaphragmatic hernia with evisceration of the stomach, transverse colon and liver into the right thorax, Ann. Surg., 137:281, 1953.

17. Phillips, J. R.: Right traumatic diaphragmatic hernia, Am. J. Surg., 63:267, 1944.

18. Rives, J. D., and Baker, D. D.: Diaphragmatic hernias of children, Ann. Surg., 115:745, 1942.

19. Shoshkes, M., and Lovelock, F. J.: Post-traumatic diaphragmatic hernia of a segment of liver simulating an anomalous lobe of the liver, Am. J. Roentgenol., 70:575, 1953.

20. Strode, E. C., and Vance, C. A.: Herniation of the right diaphragm secondary to trauma, Ann. Surg., 137:609, 1953.

21. Unger, S. M.: Right sided traumatic diaphragmatic hernia simulating a pleural effusion, J.A.M.A., 151:734, 1953.