Rupture of the diaphragm

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Symptoms, diagnostic procedures, and treatment are mentioned. A high index of suspicion of the diagnosis of ruptured diaphragm is most important in patients with a history of trauma.

Familiarity with the signs on the plain chest film is important. Furthermore, we advocate an additional examination, that is diagnostic pneumoperitoneum, in all cases of suspected rupture of the diaphragm.

If doubt still exists, we consider the final diagnostic procedure of choice to be exploratory thoracotomy until proof of the complete reliability of diagnostic pneumoperitoneum has been established.

The clinical manifestations of traumatic diaphragmatic hernia were described by Paré in 1580, and a torn left diaphragm was successfully repaired in 1899 by Walker (Andrus and Morton, 1970).

A traumatic lesion of the diaphragm is infrequent except in wartime but is seen with increasing frequency resulting from traffic accidents.

In the Anglo-Saxon literature from the period 1958–69, Hood (1971) collected 429 cases of rupture of the diaphragm. Seventy-eight patients died.

Hood concluded that the deaths reflect two facts: frequently the diagnosis of ruptured diaphragm is overlooked, and associated injuries in many patients result in death.

Lately, several patients have been admitted to the department of thoracic surgery with undiagnosed rupture of the diaphragm. To draw attention to this lesion we present our material compiled during the past 23 years. Symptoms, diagnosis, and operative procedures will be discussed. Especially we advocate the old but infrequently applied procedure of diagnostic pneumoperitoneum.

PATIENTS

Twenty-five patients were operated upon for ruptured diaphragm in the department of thoracic surgery, Rigshospitalet, during the period 1950–73.

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The rupture occurred on the left side in 18 patients and on the right side in seven patients. The rupture was never bilateral. In 21 patients the associated injuries listed in Table I were seen—some combined. Twenty patients were males, five females, their ages ranging from 10 to 78 years. Traffic accidents caused the lesion in 17 patients; falls were responsible in three cases. The rupture originated from stab lesions in four patients, and from disruption of a surgical wound of the diaphragm in one patient only. In all, four patients died.

<table>
<thead>
<tr>
<th>TABLE I</th>
</tr>
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<tbody>
<tr>
<td>TYPE OF ASSOCIATED INJURIES SEEN IN 21 PATIENTS</td>
</tr>
<tr>
<td>Type of Injury</td>
</tr>
<tr>
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</tr>
<tr>
<td>Fracture (excepting thoracic cage)</td>
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<tr>
<td>Liver lesion</td>
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<tr>
<td>Spleen rupture</td>
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<tr>
<td>Digestive tract lesion</td>
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<tr>
<td>Cerebral lesion</td>
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</table>

DIAGNOSIS

In 12 patients the diagnosis was established during the first 10 post-traumatic days. In this group an elevated and blurred diaphragm, pleural effusion, lower lobe atelectasis, and a viscus in an abnormally high position seen in the chest film taken on admission confirmed the indication for thoracotomy. Excepting symptoms referable to
the thorax, no subjective complaints were recorded in this group.

The diagnosis was established in the remaining 13 patients 10 days to four and a half years following the trauma. Among these patients seven complained of pain in the lower thorax radiating to the shoulder, epigastric pain, and dyspnoea. Three patients had no symptoms at all but were admitted exclusively because of the permanent abnormal findings in the chest radiograph.

CHEST RADIOGRAPH A preoperative film was available in 24 patients, since one patient with a stab wound was operated on immediately after admission.

All patients were examined in recumbent position, some in the upright position as well. The findings are presented in Table II.

<table>
<thead>
<tr>
<th>Abnormal Findings</th>
<th>No. of Patients</th>
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<tbody>
<tr>
<td>Apparently high cupola of the diaphragm</td>
<td>22</td>
</tr>
<tr>
<td>Gas-containing viscus in high position</td>
<td>17</td>
</tr>
<tr>
<td>Mediastinum displaced to opposite side</td>
<td>15</td>
</tr>
<tr>
<td>Atelectasis at the lung base</td>
<td>21</td>
</tr>
<tr>
<td>Pleural effusion</td>
<td>16</td>
</tr>
<tr>
<td>Fractures in thoracic cage</td>
<td>10</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>1</td>
</tr>
</tbody>
</table>

The lungs and diaphragmatic domes were normal in the film in one patient only, a young man with a stab wound, but in this patient an enlarged heart shadow demonstrated the presence of haemopericardium.

Barium meal or enema examinations were performed in seven patients to confirm an abnormally high position of the stomach or the bowels. In all these patients the abnormal position was confirmed, and in two patients a constriction of the stomach at the level of the rupture directly confirmed the diagnosis of herniation.

DIAGNOSTIC PNEUMOPERITONEUM Conventional chest radiographs and barium examinations do not demonstrate the diaphragmatic rupture itself. The differential diagnosis between a rupture and an elevation of the diaphragm may be difficult in some cases. By insufflation of air into the peritoneal cavity (diagnostic pneumoperitoneum) the diaphragm itself can always be localized, and if a pneumothorax results, the diagnosis of rupture is established.

With the aim of investigating the reliability of this examination we have performed diagnostic pneumoperitoneum, when possible, in all patients admitted during the last two years planned to be operated on for suspected rupture of the diaphragm.

Altogether nine patients were examined. In two patients a rupture of the diaphragm was diagnosed: one was left-sided (Fig. 1) and was constantly diagnosed as a post-traumatic paralytic of the diaphragm during four and a half years; the other was right-sided (Fig. 2), an acute rupture with herniation of the whole liver.

In seven patients we found an elevated intact diaphragm by pneumoperitoneum (Figs 3 and 4). Three patients underwent no exploratory thoracotomy because of age and an unconvincing clinical picture. The four other patients had thoracotomy performed, and the diagnosis established by pneumoperitoneum was verified in all.

The technique for diagnostic pneumoperitoneum is simple. Using local anaesthesia, the pneumoperitoneum in the left hypogastric region is punctured with a thin Teflon catheter fitted with an inner metal needle (Longwell 18 G). During puncture saline is injected through the needle, and when resistance can no longer be felt the inner needle is removed and the Teflon catheter needle is further advanced over a soft metal guide wire. Atmospheric air is insufflated until the patient expresses a feeling of diffuse pressure in the abdomen, usually after 400 ml. The air is directed to the side of suspected rupture by changing the position of the patient. Chest films are taken in an upright position as possible.

TREATMENT

A thoracotomy was performed and the rupture was sutured with double interrupted silk. If herniation was present the hernial contents were reduced. In two cases strangulation of the stomach was present and resection of devitalized tissue was performed. When a patient was admitted for emergency operation the intra-abdominal organs were visualized through the diaphragmatic rupture.

DISCUSSION

A tear of the diaphragm might be the result of blunt or penetrating thoracic or thoracoabdominal trauma. As recorded in other series (Bernatz, Burnside and Clagett, 1958; Asbury, 1968), we also most frequently found the lesion on the left side. These authors state that the right diaphragm is protected by the liver. Whether this is the true explanation or whether right-sided
Rupture of the diaphragm

FIG. 1. Diagnostic pneumoperitoneum in a 43-year-old man exposed to a traffic accident four and a half years previously shows pneumothorax on the left side, indicating a rupture of the left diaphragm. (The lung border is marked by arrows.)

FIG. 2. Diagnostic pneumoperitoneum in a 38-year-old man with multiple lesions caused by a traffic accident nine days previously shows formation of a pneumothorax on the right side, indicating a rupture of the right diaphragm. (The lung border is marked by arrows.)
FIG. 3. Diagnostic pneumoperitoneum in a 43-year-old man exposed to a traffic accident four months previously shows an elevated but intact left diaphragm with basal pleural reactions. No pneumothorax is present. (The left diaphragm is marked by arrows.)

FIG. 4. Diagnostic pneumoperitoneum in a 57-year-old man suspected of rupture of the right diaphragm following a traffic accident shows an elevated but intact diaphragm. No pneumothorax is present. (The right diaphragm is marked by arrows.)
diaphragmatic lesions are most often overlooked
cannot be elicited from this material.
By far the most common aetiology was a blunt
trauma from traffic accidents, explaining the
younger persons' predominance in our material.
In most cases diagnosed, an intra-abdominal
viscus was herniated through the defect. In other
cases a tear existed without initial herniation.
Days or weeks later a hernia might result from
the higher intra-abdominal pressure compared to
that of the thorax (Andrus and Morton, 1970).
In our series four patients died. Three deaths
were caused by associated injuries. One patient
died two days after the trauma from a cerebral
lesion, another, five days after trauma from a liver
lesion. The third patient died four months post-
operatively from intractable sepsis and confluent
pneumonia. This patient was admitted with an
overlooked strangulated incisional hernia of the
diaphragm with perforation of the stomach
causing empyema.
The last patient with a stab wound died six days
postoperatively from a pulmonary embolus.
Our death rate is comparable to Hood's (1971).
Before diagnosis is discussed it should be
emphasized that most important for the diagnosis
of a diaphragmatic lesion is the high index of
suspicion when a patient is admitted after injury
(Bernatz et al., 1958; Asbury, 1968; Hill, 1972).
The complaints in uncomplicated rupture of the
diaphragm are: lower thoracic pains explained by
irritation of the diaphragm, and dyspnœa caused
by compression atelectasis and/or effusion into
the pleural cavity.
When incarceration and strangulation comp-
licate the condition varying degrees of
gastrointestinal obstruction with or without
haematemesis might be present, depending upon
which organ has been strangulated. Further comp-
lications consist of perforation, empyema, and
sepsis.
The diagnosis is based largely upon radiographic
examination. Keeping the diagnosis in mind, a
chest film will give the diagnosis or at least the
suspicion (Jensen and Lockwood, 1965).
In our series, a characteristic finding on the
chest film seen in 22 patients was the apparently
high position of the diaphragm which was in fact
the upper border of a herniated organ, and this
outline looked blurred due to pleural effusion.
Gas-containing viscus in an abnormally high
position was recorded in 17 patients.
Shift of the mediastinum to the opposite side,
seen in 15 patients, was caused by the herniated
organs, pleural effusion or change of intrapleural
pressure.
Diagnostic pneumoperitoneum, by which the
diaphragm is directly visualized, is mentioned in
the literature but not often employed (Kümmerle
and Klöss, 1957; Meschan, 1966). The reason,
presumably, is fear of air embolism and pneumo-
thonax leading to respiratory collapse (Meschan,
1966).
From a theoretical point of view diagnostic
pneumoperitoneum should be reliable in fresh
diaphragmatic tears. In overlooked diaphragmatic
ruptures adhesions from the herniated organs
might be suspected of preventing air from reach-
ing the pleural cavity. In such cases the distinct
diaphragmatic cupula will not be seen.
In our material free passage of air from the
peritoneal to the thoracic cavity was seen in a
patient injured four and a half years prior to
examination, although pronounced adhesions to
the herniated organs were seen at operation.
We intend to continue the use of pneumoperi-
toneum in all cases when the diagnosis of a dia-
aphragmatic tear is suspected but cannot be
definitely established from a plain chest film.
Until the reliability of pneumoperitoneum is
proved the indication for thoracotomy will be
provided by the plain chest radiograph
appearances.

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