Postoperative Pleural Effusion Following Upper Abdominal Surgery

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Of 128 patients who underwent upper abdominal surgery, examined by standard preoperative and postoperative chest roentgenograms for the formation of postoperative pleural effusions, 89 had postoperative pleural effusions. Their presence was not related to the type of operation, infection, serum amylase, sex, smoking habits, or weight. There was no correlation between the localization of the pleural effusions and that of the abdominal incisions. There was a positive correlation between atelectasis and pleural effusion, but no evidence of a causal relationship. Pleural effusions might be related to postoperative sodium and water retention, and aggravated by an age-related relative cardiac decompensation. Early postoperative pleural effusions are common and do not require specific treatment.

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The incidence of PPE following upper abdominal surgery has been described by only a few authors and varies from 0 to 59 percent. Subphrenic abscess has been considered as the major cause of PPE, but the relation has been severely questioned by the findings of Light and George.

The aim of this prospective study was to assess the incidence and evaluate possible causes of PPE following upper abdominal surgery.

MATERIAL AND METHODS

One hundred twenty-eight patients who had elective upper abdominal surgery participated in this study. Patients who were receiving medical treatment for lung and heart diseases and patients with increased serum creatinine were excluded, as were patients with preoperative radiologic signs of cardiac decompensation. The study was performed according to the Helsinki declaration 2, and patients gave their informed consent.

The median age was 55.6 years, and the male/female ratio was 47:51. Overweight was recorded in 38.3 percent, the criterion being that the patient weighed more than 10 percent of ideal body weight according to Natvig's height-weight table. The patient was recorded as a smoker if he had been smoking during the past four weeks before the operation (52.3 percent). Simple cholecystectomy was performed in 58.6 percent and extensive biliary and gastric surgery in 41.4 percent of the operations. The location of abdominal incision was recorded. Intraoperative and postoperative fluid replacement was administered according to internationally accepted guidelines.

The PaO₂ was determined the day before and the day after the operation. All of the patients breathed atmospheric air for at least 20 min before sampling. All patients had a preoperative PaO₂ within the normal range.

Daily morning body temperature as well as WBC count was recorded the day before operation and on days 1, 3, and 5 after operation. The serum amylase was determined on the day prior to operation and on days 1, 3, and 5 postoperatively in a smaller consecutive series of 47 of the patients.

Chest roentgenograms in two projections, with the patient standing, were obtained preoperatively and two and four days postoperatively. The x-ray films were analyzed by the same radiologist, who had no knowledge of the clinical status of the patients. The occurrence of atelectasis and pleural effusion was recorded. The atelectasis was characterized by condensation and decrease of tissue volume with a clear demarcation from normal pulmonary tissue. The number of atelectases was recorded as well as the side of localization.

Pleural effusion was registered when blurring of the phrenicocostal sinus or interlobar signs of liquid were found. To make a positive recording, there had to be a clear development from the preoperative to the postoperative chest roentgenogram.

Pulmonary congestion was registered when there was apicalization of the pulmonary flow or interstitial edema seen as fuzzy hilus on the chest roentgenogram. The statistical analyses were carried out in SAS Version V on an IBM 4361 mainframe computer. For simple hypothesis testing within two groups, we used the Wilcoxon test for unpaired data (PROC NPARIWAY). The χ² text was used for tests between groups with categoric data (PROC FREQ), and the significance level was determined at p = .05.

RESULTS

Eighty-nine patients (69.5 percent) had PPE, 56 bilateral and 33 unilateral effusions. Eighty patients (62.5 percent) had atelectases, 37 (28.9 percent) bilateral and 43 (33.6 percent) unilateral.

To simplify the correlation between atelectasis and pleural effusion, we analyzed the frequencies seen in relation to the single pleural cavity (Table 1). A slightly

<table>
<thead>
<tr>
<th>Pleural Effusion</th>
<th>Atelectasis</th>
<th>No Atelectasis</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>76</td>
<td>69</td>
<td>145</td>
</tr>
<tr>
<td>No</td>
<td>41</td>
<td>70</td>
<td>111</td>
</tr>
<tr>
<td>Total</td>
<td>117</td>
<td>139</td>
<td>256</td>
</tr>
</tbody>
</table>

χ² = 6.1, p = 0.01.

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Table 2—Correlation Between Atelectasis and Pleural Effusions According to Side Localization

<table>
<thead>
<tr>
<th>Localization of Atelectases</th>
<th>None</th>
<th>R</th>
<th>L</th>
<th>Bilateral</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
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<td>7</td>
<td>5</td>
<td>16</td>
<td>48</td>
</tr>
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<td>Right</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>16</td>
<td>28</td>
</tr>
<tr>
<td>Left</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Bilateral</td>
<td>8</td>
<td>5</td>
<td>6</td>
<td>18</td>
<td>37</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>17</td>
<td>16</td>
<td>56</td>
<td>128</td>
</tr>
</tbody>
</table>

positive statistical correlation between PPE and atelectasis ($\chi^2 = 6.1, p = 0.01$) was found. The correlation between PPE and atelectasis according to the actual localization is shown in Table 2.

Patients with PPE had a median age of 58.7 years vs 50.4 years in patients without PPE ($p = 0.01$). Also, patients with atelectases were significantly older (58.5 years) than patients without (52.4 years). There was no correlation of PPE with sex, smoking habits, or obesity.

There was neither any correlation of PPE with the type of operation nor with the site of abdominal incision (Table 3). No patients had diagnosed subphrenic abscess.

No difference was found in the frequency of PPE in the patients with pneumonic infiltrates on the chest roentgenogram, six of eight (75.0 percent), and those without, 83 of 120 (69.0 percent).

No difference was found in either the morning body temperature or the WBC count on any day before or after the operation between the groups with and without PPE. Thirteen patients had signs of pulmonary congestion on the chest roentgenogram, and 11 (84.6 percent) of these had pleural effusion. Of the 115 patients without radiologic signs of pulmonary congestion, 78 (67.8 percent) had pleural effusion. The difference was not significant ($p = 0.21$).

In the group of patients without radiologic signs of pulmonary congestion, there was no correlation between the site of incision and PPE. In patients with right subcostal incision, the exudate was found on the right side in 16 cases, on the left side in 15 cases, and bilaterally in 41 cases.

The serum amylase median prior to operation was 216 U/L. In the postoperative days 1, 3, and 5, the median value fell to 183, 125, and 160 U/L, respectively. There was no difference between the groups with and without PPE. The patients with PPE had significantly lower PaO$_2$ (median 64.5 mm Hg) than patients without PPE (median 70.5 mm Hg). In patients with atelectases the PaO$_2$ was significantly lower (median 65.3 mm Hg) than in those without atelectases (median 70.5 mm Hg).

**Discussion**

The incidence of PPE varies a great deal in different clinical studies, from 0 to 59 percent. In our material the incidence is as high as 70 percent. These apparently major discrepancies may, however, be explained as a consequence of methodologic differences. Wightman$^1$ found in a series of 455 abdominal operations one PPE, and Ti and Yong$^2$ found five pleural effusions after 346 abdominal operations. No routine preoperative and postoperative chest roentgenograms nor any special measures in elucidation were taken in any of these series. Light and George$^3$ found an incidence of 59 percent of PPE following upper abdominal surgery, which is comparable with our figures. The authors took postoperative decubitus chest roentgenograms systematically, which is a highly sensitive method of revealing pleural effusions.

In the present study preoperative and postoperative standard chest roentgenograms were taken, and by comparing these results, we found a highly sensitive and simple method of revealing pleural effusions observed as even minimal, newly developed blurring of the phrenicocostal sinus. Like Light and George, we found that patients with PPE are significantly older than patients without PPE. The incidence of PPE in our population was slightly higher than in those authors.$^3$ This may be explained by the fact that our patients were approximately 25 years older than those in the series of Light and George.

The majority of the patients in our series were operated on through a right subcostal incision and, as seen from Table 3, the localization of PPE was not correlated with the side of incision. This finding is in contrast to those of Light and George, who found larger amounts of fluid on the side of surgery. The theory of local irritation of the diaphragmatic pleura as a cause of PPE does not seem justified, since we found the same incidence of PPE no matter how extensive the surgical procedure.

An infectious cause of PPE does not seem plausible, because we found no correlation of PPE to pneumonic infiltrate on the chest roentgenogram, nor any differences in WBC and morning body temperature in patients with and without PPE. Hence, we do not find any support for the theory of Light and George$^3$ that parapneumonic effusion is due to minute areas of infection in the atelectatic lung.
Pancreatitis is a known cause of pleural effusion. During upper abdominal surgery, the pancreas may be manipulated, leading to a reactive pancreatitis, but we found no evidence of pancreatitis according to the serum amylase levels in the group with PPE. This finding is in agreement with that of Light and George, who do not consider pancreatitis as a major explanation of PPE.

In 13 patients with radiologic signs of pulmonary congestion, which may be a coarse measure of hypervolemia, 11 patients had PPE (84.6 percent). In the group of patients without signs of pulmonary congestion, the PPE frequency was 67.8 percent. The difference is not significant, but there seems to be a trend in these figures. Light and George suggested that the atelectasis may be etiologically related to the formation of pleural fluid. The loss of volume in the atelectatic lung should result in a more negative pleural pressure. This negative pressure should favor the formation of fluid. Our results do not confirm this theory, as we found PPE in as many as 69 (27.0 percent) of the pleural cavities without a concurrent atelectasis. Still, we found a positive correlation between PPE and atelectasis, which might suggest a common factor resulting in the formation of both PPE and atelectasis. The common factor could be the normal pathophysiological sodium and water retention following surgery, leading to transudation of water to the pleural cavities and accumulation of water interstitially in the lungs, giving a decreased pulmonary compliance and subsequent formation of atelectases. Age-related relative cardiac decompensation could aggravate these mechanisms.

In the present study no patients had any PPE-related condition demanding intervention such as pleurocentesis, whether for a diagnostic or a therapeutic purpose. Early pleural effusions are frequently seen postoperatively, and the surgeon should have an anticipatory attitude toward the management of PPE.

REFERENCES