Air Space Studies with Special Reference to Emphysematous Air Spaces

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Emphysematous air spaces long have been recognized as problems in diagnosis and treatment. Illustrating the difficulties has been the failure of roentgenography alone to establish suitable criteria for differentiation of air spaces from cavities due to disease per se. In the present paper there has been an attempt to elucidate the diagnoses through auscultation, pressure determinations and contrast media introduced by the transthoracic method.

These spaces have been classified as noted in Table 1. Blebs and bullae' in general are round or oval and in this study occurred mostly in the apical area. The alveolar spaces are much smaller. The basal emphysematous air spaces are much larger and more irregular in size and shape. In general they may be triangular, leaf or irregular in shape. The congenital cystic areas generally occur in upper lung fields and follow a lobular or lobar pattern. The solitary cysts probably are not true air spaces and not related to blebs and bullae and other emphysematous air spaces. This paper does not primarily deal with the classification of emphysema, nor does it propose a change in the classification. It only describes the x-ray findings in this study which fell into the divisions described above.

Statistical Data

Bronchiolar connections were demonstrated by x-ray film in approximately one-fourth of the cases, but no bronchial connections as in cavities (Table 2). Bronchiolar communications were three times more frequently demonstrated by pressures. Pressures in the pulmonary air spaces were atmospheric in 75 per cent, negative in 18 per cent and positive in 7 per cent (Table 3). Occasionally one pressure was experienced in one air space and upon advancing the needle to another space another pressure was encountered. Ordinarily atmospheric pressure would be expected, but it is easily conceivable that blockage of some of the bronchi may temporarily occur with absorption of air from the spaces to an extent that negative pressures would result. A positive pressure was encountered in only three cases, two of which had emphysema with

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superimposed thoracoplasty and the other was a congenital cystic area with superimposed infection.

It must be kept in mind that these pressures were measured mostly in one air space, occasionally two and rarely three in the same lung. This would not be a fair representation of the pressures in all the air spaces of the lung. If enough were done it may approximate a fair representation of one case.

Blebs or bullae seem to be characteristically located in the apex near the supraclavicular fossae or near another cavity or large air space. The characteristic shape in this area is oval or round. This probably is due to the supraclavicular fossae limiting these to only a smaller branch of the bronchiole. These probably represent smaller clusters of alveoli which have ruptured and intercommunicated. Bronchiolar connections were noted in 31 per cent. Figure 1 represents one in the supraclavicular area.

Often-times in searching for air spaces none is found except expanded alveolar spaces as evidenced by atmospheric pressures. The contrast medium has been introduced in these, but does not form a distinct outline as in blebs or bullae; however, on x-ray film an indistinct density is outlined the size of which depends on the amount of contrast medium used. It may be that the alveolar spaces were filled and expanded by this

<table>
<thead>
<tr>
<th>Classification</th>
<th>No.</th>
<th>per cent</th>
<th>Bronchiolar Connections per cent</th>
</tr>
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<tr>
<td>Blebs or Bullae</td>
<td>16</td>
<td>34.8</td>
<td>5</td>
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<tr>
<td>Alveolar Spaces</td>
<td>17</td>
<td>37.5</td>
<td>3</td>
</tr>
<tr>
<td>Basal Emphysematous Spaces</td>
<td>6</td>
<td>13.1</td>
<td>2</td>
</tr>
<tr>
<td>Congenital Cystic Area</td>
<td>3</td>
<td>6.5</td>
<td>0</td>
</tr>
<tr>
<td>Solitary Cyst</td>
<td>4</td>
<td>8.7</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>46</td>
<td>100</td>
<td>11</td>
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**FIGURE 1**: Oval air space more or less characteristic in supraclavicular area. Note another air space is medially and superiorly adjacent to the one demonstrated.

**FIGURE 2**: Large irregular basal air space with bronchiolar connection demonstrated.
contrast medium. No bronchial connection showed in 17 of these cases, but three bronchiolar connections were noted.

Although the above represents the results of emphysema and is part of the same process, the emphysematous air spaces seen in the basal and posterior portions of the lungs have a different appearance to blebs and bullae. They have a more or less triangular, leaf or irregular shape, are larger and more irregularly outlined. They probably represent a larger segment of the bronchiolar tree being involved. Figure 2 represents one of these segments as seen on x-ray with its bronchiolar connection. Figure 3 shows more irregularity and larger size as compared to blebs and bullae.

In the congenital cystic area there is more generalized distribution of the contrast medium. X-ray film shows a lobular or lobar distribution. No bronchiolar connections were seen in three cases. Figure 4 represents a chest x-ray film of this type of case. Note in the various air spaces demonstrated in this study no fluid level is formed by the contrast media as in cavities.

Discussion

The pressures of the various air spaces described have been found to be mostly atmospheric with a few negatives and less positives. Different pressures in the same patient in different spaces were noted. These group findings in 39 cases may be representative of the pressures that would be found in the average individual emphysematous patient, if it were possible to place the lumen of the needle in all the air spaces of the lung and measure the pressures. In these cases an atmospheric pressure was found in 75 per cent of the spaces, more or less. One probably could say as the percentage of open bronchi decreased, the severity of the condition would increase. However, it would be purely conjectural to state that if atmospheric pressures were present in only 50 per cent of the air spaces of the lungs, severe emphysema and shortness of breath would be present. Kuschnery, and others also have pointed out that actual anatomic

FIGURE 3: Large basal irregularly outlined air space. The super imposed drawing to right better illustrates the irregularity of the large emphysematous spaces.
narrowing or intraluminal obstruction cannot be demonstrated, and yet there is ample physiological evidence of bronchial narrowing. In these cases there was indirect evidence of obstruction in approximately 25 per cent of the bronchi as shown by positive pressures. There was direct evidence of non-obstruction in 24 per cent as shown by x-ray visualization of bronchioles.

It has been observed that the various types of air spaces secondary to the development of emphysema occur more frequently in the apex, posterior apex, posterior base and base. The findings in these studies may help to develop some theoretical considerations as to why these spaces localize where they do. It is not necessary to dwell here on the chronic bronchial infection or irritation, nor the change in blood supply that precedes emphysema. It should be stated that from a theoretical standpoint it is felt that cough plays a definite part in the production of air spaces. The following theoretical discussions are presented.

During the development of the cough process the contraction of the abdominal muscles depresses the anterior portion of the ribs and presses upward on the diaphragm. The initiation of pressure on the lungs is sudden in a posterior direction and upward from the diaphragm. While the pressure is increasing in the lungs in the above directions, the pressure in the apical, posterior and basal portions would be applied in the direction of the weakest portion of the alveoli. This would account for the destructive effect on the alveoli in these areas of the lungs in contra-distinction to that in the anterior area where the pressure is applied in the opposite direction. It is difficult to destroy an arch or break an egg when the pressure is applied in the direction of its greatest strength, but easy when applied in the opposite direction.

The next theory as to the development of these spaces is discussed as follows: It is observed on lateral x-ray film that these air spaces develop in the areas more peripheral from the main bronchus. Their development may be dependent on pressure gradients. These areas of the lungs are most distant from the main bronchi and the pressure gradient would be increased in them. Upon cough these would be the last and the least emptied and, therefore, the first and most injured by rupture.

The above theories may explain why emphysema localizes as it does; however, another condition plays a part in the production of these air spaces. It has been pointed out that there is an inequality of pressures in the air spaces as a result of obstruction. Whether one or the other or both of the above theories are true, the greatest effect or tear may occur in these spaces that have negative or positive pressures in the areas where there is the greatest strain. These are apical, posterior and basal in location. During the build-up of pressure in the lung for coughing, and until this pressure is released, there would be no difference in the intra-pulmonary pressures anywhere in the lungs. After the release of pressure, the air will escape faster and with more ease where there is no obstruction to the outlet. At this point an inequality of pressures will develop in the air spaces where there are negative or positive pressures. If a positive pressure is present in the blocked area, a rupture will be from within outward. If a negative pressure is present in the blocked area, a rupture would be from without inward. These inequalities of pressures in air spaces may cause distortion of the bronchial tree if there are many present. This would further obstruct or aggravate ventilation of this portion of the bronchial tree.

It is noted that air spaces in the apices, as outlined by contrast media, are generally round or oval in shape. In the base the emphysematous air spaces are larger and triangular, leaf or irregularly shaped. The location and physical properties present control the size and shape of these air spaces. During cough a small portion of the apex bulges at the suprachlavicular fossa and limits the size and shape of the blebs and bullae. These are smaller segments of the bronchial tree and its alveolar clusters. Bullae also seem to develop near cavities or other air spaces but are not as round or oval as in the supraclavicular fossa. In the basal portion of the lungs there is no limiting factor like the supraclavicular fossa. The size and shape of air spaces will be governed by the size, shape and location of the smaller bronchionle and the area it supplies. This will explain its more or less irregular size and shape. Figures 5 and 6 are representative of these space areas.

<table>
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<tr>
<th>Classification</th>
<th>Atmospheric</th>
<th>Negative</th>
<th>Positive</th>
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<tbody>
<tr>
<td>Blebs and Bullae</td>
<td>10</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Alveolar Spaces</td>
<td>10</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Basal Emphysematous</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Congenital Cyst Area</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Solitary Cyst</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bronchus</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>47</strong></td>
<td><strong>29</strong></td>
<td><strong>7</strong></td>
</tr>
</tbody>
</table>

*Pressures not registered in eight cases.

TABLE 2—PRESSURES* IN PULMONARY AIR SPACES
From an x-ray film standpoint it is difficult to differentiate cavities from air spaces; however, these studies show many differences. Pulmonary cavities show open bronchial connections in 77 per cent of the cases. Air spaces show bronchiolar or small bronchial connections in 24 per cent of the cases in contra-distinction to those observed in pulmonary cavities. Pulmonary cavities have thick walls and air spaces no definite walls. Completely blocked cavities frequently show sinus tracts where none are seen in air spaces. No fluid level is formed by contrast media in air spaces as it does in cavities. The findings in air spaces are completely different to those in pulmonary cavities.

SUMMARY
1. Forty-seven cases of emphysematous air spaces have been studied by introducing contrast media, taking pressures and doing intrapulmonary auscultation.
2. These studies have demonstrated blebs, bullae, alveolar spaces, basal emphysematous spaces, congenital cystic areas and solitary cysts. Blebs and bullae appear to be more frequent in apical portion and the larger emphysematous air spaces in basal portion of the lungs.

RESUMEN
1. Cuarenta y siete casos de espacios enflamatosos se estudian introduciendo medios de contraste, midiendo las presiones y haciendo auscultación intrapulmonar.
2. Estos estudios han demostrado burbujas, bullas, espacios alveolares, espacios basales enfisematosos, áreas de quistes congénitos y quistes solitarios. Las burbujas y las bullas aparecen mas frecuentemente en la región apical y los espacios enfisematosos mas grandes se ven en las bases.

RESUMÉ
1. 47 cas où existaient des zones aériques emphysémateuses ont été étudiés par introduction d’un milieu de contraste, avec mesure des pressions et auscultation pulmonaire.

ZUSAMMENFASSUNG
1. 47 Fälle mit emphysematösen lufthaltigen Lungenbezirken wurden untersucht mittels Einführung von Kontrastmedien, Druckmessung und intrapulmonaler Auskultation.

REFERENCES

ISOLATION OF THE RESPIRATORY SYNCYTIAL VIRUS
FROM A PATIENT WITH PNEUMONIA

A virus with the characteristics of the respiratory syncytial virus was isolated from the throat of a six-month old infant with pneumonia. The illness was accompanied by an eightfold increase in complement fixation antibody to the Long strain of the respiratory syncytial virus and a sixteenfold rise in the homologous neutralizing antibody, indicating that the pneumonia was accompanied by infection with this virus. The relationship between this infection and the patient’s pneumonia is possibly etiologic.