Pseudo Left Axis Deviation and the $S_1S_2S_3$
Syndrome in Chronic Airway Obstruction*

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Pseudo left axis deviation (not true left axis deviation) and the $S_1S_2S_3$ syndrome are infrequently reported electrocardiographic findings in chronic airway obstruction. One hundred fifty-eight patients with severe chronic airway obstruction documented by pulmonary function testing were evaluated for these electrocardiographic findings. Pseudo left axis deviation was found in 23 patients (15 percent), and the $S_1S_2S_3$ syndrome was found in 14 patients (9 percent). The electrocardiographic and vectorcardiographic findings are illustrated.

Numerous reports are available on the electrocardiographic findings in chronic airway obstruction. Many authors have noted that a small percentage of patients with pulmonary emphysema have left axis deviation in the absence of clinical coronary artery disease, systemic hypertension, or other causes of myocardial failure. In the Denver area, where there is a significant reduction in the ambient oxygen pressure contributing to an increased frequency of chronic airway obstruction, we have been impressed with the number of patients who have pseudo left axis deviation or the $S_1S_2S_3$ syndrome, presumably due to chronic airway obstruction. The following report illustrates these electrocardiographic and vectorcardiographic findings.

**DATA SOURCE**

For the first part of our study, a group of 58 patients with severe chronic airway obstruction who were evaluated by right cardiac catheterization were studied. All were men patients followed-up extensively in the chest clinic at the Denver Veterans Administration Hospital. All studies were done during optimal clinical status. The ejection fraction and cardiac index were measured using radioactive isotopic techniques previously reported.

For the second part of the study, 100 patients from the University of Colorado Medical Center, Denver, were randomly selected on the basis of severe chronic airway obstruction determined by pulmonary function testing. All of these patients had a ratio of forced expiratory volume in one second to vital capacity (FEV$_1$/VC) of less than 45 percent. There were 25 women and 75 men patients, with an average age of 61 years.

Of the group of 58 patients with severe chronic airway obstruction who were evaluated by right cardiac catheterization, 11 patients were found to have pseudo left axis deviation, and three patients had the $S_1S_2S_3$ syndrome. Table 1 is a summary of the relevant data on hemodynamic and pulmonary function documenting severe chronic airway obstruction in these 14 patients (24 percent). Of the 14 patients, only two had clinical coronary artery disease, and none had systemic hypertension. The results show a significant increase in pulmonary artery pressure due to chronic airway obstruction with little change in the other hemodynamic measurements.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Mean (Range)</th>
<th>Normal</th>
</tr>
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<tbody>
<tr>
<td>Age, yr</td>
<td>64 (54-79)</td>
<td>...</td>
</tr>
<tr>
<td>Pressure, mm Hg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right atrium</td>
<td>5 (0-13)</td>
<td>6 ± 2</td>
</tr>
<tr>
<td>Pulmonary artery</td>
<td>30 (15-52)</td>
<td>17 ± 3</td>
</tr>
<tr>
<td>Pulmonary arterial wedge</td>
<td>9 (3-15)</td>
<td>12 ± 2</td>
</tr>
<tr>
<td>Ejection fraction, percent</td>
<td>60 (39-71)</td>
<td>65 ± 10</td>
</tr>
<tr>
<td>Cardiac index, L/min/sq m</td>
<td>3.4 (2.7-3.9)</td>
<td>2.7-3.8</td>
</tr>
<tr>
<td>FEV$_1$/VC, percent</td>
<td>44 (23-50)</td>
<td>&gt;75</td>
</tr>
<tr>
<td>pH</td>
<td>7.41 (7.32-7.45)</td>
<td>7.35-7.45</td>
</tr>
<tr>
<td>Arterial carbon dioxide tension, mm Hg</td>
<td>41 (28-58)</td>
<td>37 ± 2</td>
</tr>
<tr>
<td>Arterial oxygen pressure, mm Hg</td>
<td>56 (33-74)</td>
<td>70 ± 5</td>
</tr>
</tbody>
</table>

*Eleven patients with pseudo left axis deviation and three patients with $S_1S_2S_3$ syndrome.

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Figure 1A (upper). ECG illustrating pseudo left axis deviation. 1B (lower). Vectorcardiogram of patient whose ECG is shown in Figure 1A.

Figure 1 illustrates the electrocardiogram and vectorcardiogram in pseudo left axis deviation with right ventricular hypertrophy due to chronic airway obstruction. The salient features include an inferior P vector giving prominent P waves in leads 2, 3, and aVF and an inverted P wave in lead aVL. There is low voltage in both the frontal and horizontal planes. In the frontal plane the QRS loop is counterclockwise with the mean frontal QRS axis (ÅQRS) at 270°, with rightward and superior terminal forces giving terminal R waves in leads aVR and aVL of similar magnitude and configuration. In the horizontal plane the terminal QRS loop is rightward and posterior, causing a deep S in leads V₅ to V₆ and a
shallow notched S in lead V1. Figure 2 illustrates the ECG of the S2S3S3 syndrome, which is quite similar to pseudo left axis deviation in terms of the P vector and low voltage. The initial QRS force is leftward and inferior, which then swings rightward and superior with the loop rotating through the electrical center of the heart and the terminal forces arriving at 210°.

Of the 100 randomly selected patients with severe chronic airway obstruction documented by pulmonary function testing, there were 14 patients with pseudo left axis deviation. One patient had clinical coronary artery disease, and one patient had systemic hypertension. There were also nine patients who had the S2S3S3 syndrome. Thus, 23 percent of these patients with severe chronic airway obstruction had an ECG showing pseudo left axis deviation or the S2S3S3 syndrome.

DISCUSSION

Considerable debate exists as to the relative frequency and diagnostic value of the various electrocardiographic findings in chronic airway obstruction.1-7 The most frequently reported abnormalities are (1) an inferior P vector, (2) P-pulmonale, (3) right axis deviation with a superior and posterior terminal QRS vector, and (4) low voltage. The incidence of left axis deviation in chronic airway obstruction has been reported to vary between 2 and 13 percent.1-10 Some of these patients had coronary artery disease, hypertension, etc, to explain the presence of left axis deviation, but the majority did not. Although the S2S3S3 syndrome has been reported in chronic airway obstruction, it is frequently seen in "normal" subjects, and the incidence in chronic airway obstruction is unknown. The cause for this pseudo left axis deviation is unknown but presumably related to a marked reduction in the electrical conductance in the emphysematous lungs and to the thoracic deformity which causes the heart to shift leftward and posterior in position and not due to anterior fascicular block.10 Our experience suggests that pseudo left axis deviation and the S2S3S3 syndrome are frequently seen in patients with severe chronic airway obstruction.

REFERENCES

8 Littman D: The electrocardiographic findings in pulmonary emphysema. Am J Cardiol 5:339-348, 1960