Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value of the 12-Lead Electrocardiogram in Predicting Right Ventricular Hypertrophy Diagnosed by a 2-Dimensional Echocardiogram in Patients with Moderate or Severe Chronic Obstructive Pulmonary Disease Followed in an Academic Outpatient Pulmonary Clinic

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Keywords: chronic obstructive pulmonary disease; right ventricular hypertrophy; electrocardiogram; 2-dimensional echocardiogram

ABSTRACT

Patients with chronic obstructive pulmonary disease (COPD) have a higher incidence of heart failure and reduced survival if they have right ventricular hypertrophy (RVH). We investigated the sensitivity, specificity, positive predictive value, and negative predictive value of the 12-lead ECG in predicting RVH diagnosed by 2-dimensional echocardiography in 50 patients with moderate or severe COPD followed in an academic pulmonary clinic. The ECGs and echocardiograms were interpreted blindly by the investigators. Of the 50 patients, 10 (20%) had RVH diagnosed by the ECG, and 20 (40%) had RVH diagnosed by the echocardiogram. The sensitivity, specificity, positive predictive value, and negative predictive value of the 12-lead electrocardiogram (ECG) in diagnosing RVH were 50%, 100%, 100%, and 75%, respectively. In conclusion, RVH diagnosed by ECG has a very high specificity but a lower sensitivity than the echocardiogram in diagnosing RVH in patients with COPD.

INTRODUCTION

Chronic obstructive pulmonary disease may cause pulmonary hypertension and right ventricular hypertrophy known as chronic cor pulmonale [1]. Patients with chronic obstructive pulmonary disease have a higher incidence of heart failure and reduced survival if they have right ventricular hypertrophy [2-10]. Therefore, it is clinically important to know whether patients with
chronic obstructive pulmonary disease have right ventricular hypertrophy.

Right ventricular hypertrophy may be diagnosed by electrocardiography [11] and more accurately by 2-dimensional echocardiography [12,13]. To the best of our knowledge, the sensitivity, specificity, positive predictive value, and negative predictive value of the 12-lead electrocardiogram in diagnosing right ventricular hypertrophy diagnosed by 2-dimensional echocardiography in patients with chronic obstructive pulmonary disease has not been previously reported. The present study investigated the sensitivity, specificity, positive predictive value, and negative predictive value of the 12-lead electrocardiogram in predicting right ventricular hypertrophy diagnosed by 2-dimensional echocardiography in 50 patients with moderate or severe chronic obstructive pulmonary disease followed in an academic pulmonary clinic.

MATERIALS AND METHODOLOGY

The patients included 29 men and 21 women, mean age 67 ± 10 years, followed in the outpatient pulmonary clinic at Westchester Medical Center/New York Medical College with moderate or severe chronic obstructive pulmonary disease diagnosed by pulmonary function tests. There were no inclusion or exclusion criteria. Severe COPD was diagnosed if the percent predicted forced expiratory volume in 1 second was <50%. Moderate COPD was diagnosed if the percent predicted forced expiratory volume in 1 second was 50-70%. The pulmonary function tests were analyzed by 2 investigators blindly who were unaware of the results of the 12-lead electrocardiograms and 2-dimensional echocardiograms taken in these 50 patients. None of the 50 patients had any cardiovascular disease. The electrocardiograms and echocardiograms were obtained in these 50 patients to diagnose right ventricular hypertrophy.

Electrocardiograms in these 50 patients were analyzed blindly by an experienced electrocardiographer (WSA) who had no knowledge of the pulmonary function results or the results of the 2-dimensional echocardiograms. The electrocardiograms were analyzed blindly twice with no difference in results found. The 2-dimensional echocardiograms were analyzed blindly by an investigator (DH) who had no knowledge of the results of the pulmonary function tests or the results of the 12-lead electrocardiograms.

Right ventricular hypertrophy was diagnosed by the 12-lead electrocardiogram according to the criteria by Scott et al [11]. These electrocardiographic criteria for right ventricular hypertrophy were those of a qR pattern in V3r or V1, an R wave in V1 of 7 mm or greater, an R to S ratio in V1 greater than 1, or a delay in the onset of the intrinsicoid deflection in V1 of from 0.035 to 0.05 second [11].

The thickness of the right ventricular free wall was measured in the 4-chamber view. Right ventricular hypertrophy was diagnosed by the 2-dimensional echocardiogram if the right ventricular free wall thickness was ≥ 0.50 cm [12,13]. Right ventricular enlargement, pulmonary artery systolic pressure, and right ventricular ejection fraction were also measured according to American Society of Echocardiography guidelines and right ventricular enlargement, pulmonary hypertension, and abnormal right ventricular ejection fraction diagnosed according to their guidelines [13].

Using the 2-dimensional echocardiogram as the gold standard for diagnosing right ventricular hypertrophy, the sensitivity, specificity, positive predictive value, and negative predictive value of the 12-lead electrocardiogram in diagnosing right ventricular hypertrophy were calculated. The sensitivity was calculated by dividing true positives by true positives plus false negatives and multiplying the result by 100%. The specificity was calculated by dividing true negatives by true negatives plus false positives and multiplying the result by 100%. The positive predictive value was calculated by dividing true positives by true positives plus false positives and multiplying the result by 100%. The negative predictive value was calculated by dividing true negatives by true negatives plus false negatives and multiplying the result by 100%.

RESULTS

Of the 50 patients, 10 (20%) had right ventricular hypertrophy diagnosed by the 12-lead electrocardiogram, and 20 (40%) had right ventricular hypertrophy diagnosed by the 2-dimensional echocardiogram. Using the 2-
dimensional echocardiogram as the gold standard for diagnosing right ventricular hypertrophy, the sensitivity, specificity, positive predictive value, and negative predictive value of the 12-lead electrocardiogram in diagnosing right ventricular hypertrophy were 50%, 100%, 100%, and 75%, respectively (Table 1).

Table 1. Sensitivity, specificity, positive predictive value, and negative predictive value of the 12-lead electrocardiogram in diagnosing right ventricular hypertrophy diagnosed by a 2-dimensional echocardiogram in patients with moderate or severe chronic obstructive pulmonary disease

<table>
<thead>
<tr>
<th>Variable</th>
<th>Percent</th>
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<tbody>
<tr>
<td>Sensitivity</td>
<td>50%</td>
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<tr>
<td>Specificity</td>
<td>100%</td>
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<tr>
<td>Positive predictive value</td>
<td>100%</td>
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<tr>
<td>Negative predictive value</td>
<td>75%</td>
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</tbody>
</table>

Of the 50 patients, 22 (44%) had pulmonary hypertension with a pulmonary artery systolic pressure greater than 30 mm Hg. The sensitivity of electrocardiographic right ventricular hypertrophy in predicting echocardiographic pulmonary hypertension was 46%. The specificity of electrocardiographic right ventricular hypertrophy in predicting echocardiographic pulmonary hypertension was 100%.

Of the 50 patients, 16 (30%) had right ventricular enlargement. The sensitivity of electrocardiographic right ventricular hypertrophy in predicting echocardiographic right ventricular enlargement was 63%. The specificity of electrocardiographic right ventricular hypertrophy in predicting echocardiographic right ventricular enlargement was 100%.

Of the 50 patients, 11 (22%) had an abnormal right ventricular ejection fraction. The sensitivity of electrocardiographic right ventricular hypertrophy in predicting echocardiographic abnormal right ventricular ejection fraction was 82%. The specificity of electrocardiographic right ventricular hypertrophy in predicting echocardiographic abnormal right ventricular ejection fraction was 98%.

DISCUSSION

Patients with chronic obstructive pulmonary disease have a higher incidence of heart failure and reduced survival if they have right ventricular hypertrophy [2-10]. Therefore, it is clinically important to know whether patients with chronic obstructive pulmonary disease have right ventricular hypertrophy. Patients with chronic obstructive pulmonary disease and right ventricular hypertrophy must be treated more intensively.

Scott et al [10] reported that right ventricular hypertrophy was present on the electrocardiogram in 8 of 28 patients (29%) with severe chronic obstructive pulmonary disease. In the present study, right ventricular hypertrophy was present on the electrocardiogram in 10 of 50 patients (20%) with moderate or severe chronic obstructive pulmonary disease. In the present study, right ventricular hypertrophy was present on the 2-dimensional echocardiogram in 20 of 50 patients (40%) with moderate or severe chronic obstructive pulmonary disease.

To the best of our knowledge, the sensitivity, specificity, positive predictive value, and negative predictive value of the 12-lead electrocardiogram in diagnosing right ventricular hypertrophy diagnosed by 2-dimensional echocardiography in patients with chronic obstructive pulmonary disease has not been previously reported. Using the 2-dimensional echocardiogram as the gold standard for diagnosing right ventricular hypertrophy, the sensitivity, specificity, positive predictive value, and negative predictive value of the 12-lead electrocardiogram in diagnosing right ventricular hypertrophy were 50%, 100%, 100%, and 75%, respectively. The major limitation of this study is its small sample size.

Myocardial hypertrophy is difficult to be assessed. Three-dimensional echocardiography[14] and cardiac magnetic resonance imaging [15] are the gold standard techniques for the detection of right ventricular hypertrophy but are not available for clinical use in many institutions.

On the basis of these data, we can conclude that if right ventricular hypertrophy is present on the 12-lead electrocardiogram in patients with chronic obstructive pulmonary disease, the patient has right ventricular hypertrophy and a 2-dimensional echocardiogram is not necessary to diagnose right ventricular hypertrophy. However, if right ventricular hypertrophy is not present on the 12-lead electrocardiogram, a 2-dimensional echocardiogram should be obtained because
patients with chronic obstructive pulmonary disease and right ventricular hypertrophy have a worse prognosis than these patients without right ventricular hypertrophy and need more intensive treatment.

CONFLICT OF INTEREST

None of the authors have any conflicts of interest.

REFERENCES


