Usefulness of Left and Right Oblique Subcostal View in the Echo-Doppler Investigation of Pulmonary Arterial Blood Flow in Patients with Chronic Obstructive Pulmonary Disease* 

The Subxiphoid View in the Echo-Doppler Evaluation of Pulmonary Blood Flow

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Fifty-nine adult patients with chronic obstructive pulmonary disease (COPD) underwent Doppler and two-dimensional echocardiographic examination to determine the variability of pulmonary arterial blood flow (PABF) from multiple views. Measurement of peak flow velocity (FFV), acceleration time (AT), right ventricular ejection time (RVET), and pulmonary arterial diameter (PAD) was possible in 52 patients (88 percent) by left oblique subcostal view (LOSV), in 38 patients (64.4 percent) by right oblique subcostal view (ROSV), and in only 12 patients (20.3 percent) by short axis parasternal view (SAPV) (p<0.05). Overall, PABF was measured in 55 patients (93.2 percent). The LOSV gave consistently higher values of PFV than those obtained either by ROSV (p<0.05) or by SAPV (p<0.05). We conclude that LOSV and ROSV allow measurement of PABF in the majority of patients with COPD.

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Clinical experience has shown the accuracy of Doppler-echocardiographic measurement of pulmonary arterial blood flow (PABF). The presence of pulmonary hypertension can be diagnosed by analyzing hemodynamic data obtained by Doppler analysis. Several mathematic equations have been formulated to calculate pulmonary vascular pressure and resistance values for noninvasive hemodynamic Doppler data. The short axis parasternal view (SAPV) is the most common echocardiographic approach in the evaluation of PABF in adults. In patients with chronic obstructive pulmonary disease (COPD), the SAPV is seldom feasible due to lung hyperinflation. The aim of our study was to assess the feasibility and accuracy of the left oblique subcostal view (LOSV) and the right oblique subcostal view (ROSV) in the echo-Doppler investigation of PABF in patients with COPD.

METHODS

Fifty-nine patients affected by COPD were included in the study. Each patient underwent chest roentgenographic and hemogas analysis that confirmed the diagnosis of severe COPD according to the classification of Morris.* Ages ranged from 16 to 80 years (mean, 66 ± 12 years). There were 43 men and 16 women. All but six patients had sinus rhythm; six patients had atrial fibrillation. Patients were examined with a Doppler ultrasound instrument (Hewlett Packard HP). A 2.5-MHz probe and a 5-mm Doppler sample volume were used. The study was recorded on videotape; the subcostal view images were turned upside down before taping. For each patient three echocardiographic views were used:

(1) LOSV: The patient was supine. The LOSV was obtained from the four-chamber view by a 40° to 50° rotation of the transducer toward the middle part of the left clavicle. Figure 1A shows the right ventricle, the pulmonary valve, the right ventricular outflow tract, and the pulmonary trunk visualized by LOSV.

(2) ROSV: The patient was supine. The ROSV was obtained from the four-chamber view by a counterclockwise rotation of the transducer toward the middle part of the right clavicle. Figure 1B shows the right atrium, right ventricle, pulmonary artery, and its main branches visualized by ROSV.

(3) SAPV: This was obtained from the parasternal area with patients in the left lateral decubitus position.

To determine pulmonary artery flow, we placed the sample volume in the middle of the right ventricular outflow tract, just below the pulmonary valve (Fig 2). Doppler flow waveforms were recorded on a videotape only when the Doppler signal was very clear and reproducible and peak flow velocity (PFV), acceleration time (AT), right ventricular ejection time (RVET), and pulmonary arterial diameter (PAD) could be easily calculated (Fig 3). Average values of PFV, AT, RVET, and PAD were calculated during five consecutive cardiac beats in order to decrease the influence of respiratory movements. Student's t test and x2 test were used for statistical comparisons where appropriate.

RESULTS

We were able to obtain good quality Doppler-
echocardiographic recordings of the PABF in 52 patients (88 percent) using the LOSV and in 38 patients (64.4 percent) using the ROSV, whereas the SAPV was possible only in 12 patients (20.3 percent). This difference was statistically significant (p<0.05). In four patients (6.7 percent) none of the three approaches allowed adequate Doppler-echocardiographic evaluation. Overall, the PABF was measured in 55 patients (93.2 percent) (Table 1).

Table 2 shows the PFV, AT, RVET, and PAD obtained by the three different approaches.

In 37 patients (62.7 percent), we were able to assess the same parameters either in the LOSV or in the ROSV; PFV values, determined by the LOSV, were significantly higher than those obtained by ROSV (p<0.05). Similar values of AT, RVET, and PAD resulted by using the two subcostal views (p=NS) (Table 3).

In ten patients, PFV, AT, RVET, and PAD were determined in both LOSV and SAPV, and higher values of PFV were recorded in the LOSV (p<0.05) (Table 4).

**DISCUSSION**

The combined use of two-dimensional echocardiography and pulsed Doppler allow easy placement of the sample volume close to the pulmonary valve. Some authors have shown the accuracy of noninvasive pulmonary blood flow assessment to detect pulmonary hypertension and several methods of investigation have been proposed. Multiple echocardiographic views and sample volume positioning are essential to determine the higher peak flow velocity. Lighty and colleagues evaluated 40 adult patients and found that the SAPV did not always give the maximum pulmonary blood flow velocity; they recommended routine use of multiple views in the echo-

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**Table 1—Doppler Recording of Pulmonary Arterial Blood Flow in 59 Patients**

<table>
<thead>
<tr>
<th>View*</th>
<th>Adequate Recordings</th>
<th>% (n=59)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOSV</td>
<td>52</td>
<td>88.1</td>
</tr>
<tr>
<td>ROSV</td>
<td>38</td>
<td>64.4</td>
</tr>
<tr>
<td>SAPV</td>
<td>12</td>
<td>20.3</td>
</tr>
<tr>
<td>LOSV and ROSV</td>
<td>37</td>
<td>62.7</td>
</tr>
<tr>
<td>LOSV and SAPV</td>
<td>10</td>
<td>16.9</td>
</tr>
<tr>
<td>None</td>
<td>4</td>
<td>6.7</td>
</tr>
</tbody>
</table>

*LOSV = left oblique subcostal view; ROSV = right oblique subcostal view; and SAPV = short axis parasternal view.

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**Figure 1A (upper).** Left oblique subcostal view (LOSV). B (lower). Right oblique subcostal view (ROSV). AO = aorta; LV = left ventricle; PV = pulmonary valve; RV = right ventricle; and RA = right atrium.
Doppler evaluation of adult patients.

In patients with COPD, measurement of PABF is difficult because of anatomic obstacles (emphysema). In these patients, the classic SAPV is seldom feasible.7,8 In our study, we showed that the two oblique subcostal views give the possibility of assessing PABF.

The LOSV examination is quite common in pediatric patients,9,10 but to our knowledge, it has never been used in adult patients. The results of our study show that the LOSV allows the possibility of measuring the PABF in the majority of patients with COPD and that the echo-Doppler values of PFV, AT, RVET, and PAD correlate well with those obtained by the ROSV.

In our study, we also showed that the ROSV is a valid alternative to assess the pulmonary blood flow in patients with COPD. Okamoto and colleagues14 underlined the importance of determining pulmonary flow by positioning the Doppler sample volume in different sites, especially in patients affected by pulmonary hypertension and pulmonary artery idiopathic dilatation. It is our opinion that, in the former cases, the ROSV is more useful because it allows a more

Table 2—Pulmonary Blood Flow: Echo-Doppler Parameters and Pulmonary Diameters from Subcostal and Parasternal Views

<table>
<thead>
<tr>
<th>View</th>
<th>PFV (cm/s), Mean ± SD</th>
<th>AT (m/s), Mean ± SD</th>
<th>RVET (m/s), Mean ± SD</th>
<th>PAD (cm), Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOSV (n = 52)</td>
<td>97 ± 13</td>
<td>93 ± 17</td>
<td>277 ± 42</td>
<td>1.94 ± 0.32</td>
</tr>
<tr>
<td>ROSV (n = 38)</td>
<td>94 ± 15</td>
<td>94 ± 18</td>
<td>290 ± 43</td>
<td>1.90 ± 0.26</td>
</tr>
<tr>
<td>SAPV (n = 12)</td>
<td>82 ± 12</td>
<td>98 ± 18</td>
<td>278 ± 20</td>
<td>1.81 ± 0.46</td>
</tr>
</tbody>
</table>

*PFV = peak flow velocity; AT = acceleration time; RVET = right ventricular ejection time; PAD = pulmonary arterial diameter; LOSV = left oblique subcostal view; ROSV = right oblique subcostal view; and SAPV = short axis parasternal view.
precise definition of the supravalvular area and of the pulmonary trunk, namely when blood flow is not laminar. When obtainable, ROSV provides better images of the vessel and it is preferable for the measurement of PAD. However, in our analysis, there was no statistical difference between the vessel diameters obtained from the two subcostal approaches.

We can conclude that LOSV and ROSV allow the investigation of PABF in a large number of patients with COPD when the usual parasternal view is not feasible. The results of our study, confirm the need for multiple views in the routine echo-Doppler analysis of PABF.

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REFERENCES


Table 3—Pulmonary Blood Flow Values and Pulmonary Diameters in 37 Patients in Whom Both LOSV and ROSV Were Feasible*

<table>
<thead>
<tr>
<th>View</th>
<th>PFV (cm/s), Mean ± SD</th>
<th>AT (m/s), Mean ± SD</th>
<th>RVET (m/s), Mean ± SD</th>
<th>PAD (cm), Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOSV</td>
<td>97 ± 13</td>
<td>93 ± 17</td>
<td>278 ± 43</td>
<td>1.97 ± 0.33</td>
</tr>
<tr>
<td>ROSV</td>
<td>94 ± 15</td>
<td>94 ± 18</td>
<td>278 ± 43</td>
<td>1.90 ± 0.27</td>
</tr>
</tbody>
</table>

*pPFV = peak flow velocity; AT = acceleration time; RVET = right ventricular ejection time; PAD = pulmonary arterial diameter; LOSV = left oblique subcostal view; ROSV = right oblique subcostal view; and NS = not significant.

Table 4—Pulmonary Blood Flow Values and Pulmonary Diameters in 10 Patients in Whom Both LOSV and SAPV Were Feasible*

<table>
<thead>
<tr>
<th>View</th>
<th>PFV (cm/s), Mean ± SD</th>
<th>AT (m/s), Mean ± SD</th>
<th>RVET (m/s), Mean ± SD</th>
<th>PAD (cm), Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOSV</td>
<td>97 ± 13</td>
<td>98 ± 18</td>
<td>273 ± 25</td>
<td>1.87 ± 0.50</td>
</tr>
<tr>
<td>SAPV</td>
<td>83 ± 12</td>
<td>99 ± 18</td>
<td>277 ± 20</td>
<td>1.81 ± 0.44</td>
</tr>
</tbody>
</table>

*pPFV = peak flow velocity; AT = acceleration time; RVET = right ventricular ejection time; PAD = pulmonary arterial diameter; LOSV = left oblique subcostal view; SAPV = short axis parasternal view; and NS = not significant.