Conventional Radiology and Right Heart Catheterization in Estimating Primary Pulmonary Hypertension and Pulmonary Hypertension Secondary to Left-sided Valvular Disease

Dan Radulescu*, Sorin Pripon**, Caius Duncea***, Nicolae A. Constantea****, Iulia Gulei*****

ABSTRACT

Aim: to estimate the comparative value of conventional radiology and cardiac catheterization in establishing the diagnosis and severity of primary and secondary pulmonary hypertension. We also tried to achieve some correlations between the radiological and invasive parameters.

Methods: we performed a retrospective study over an 11-years time period, analyzing data from a group of 14 patients diagnosed with primary pulmonary hypertension compared to a matched group of 20 patients suffering from pulmonary hypertension secondary to mitral and aortic valvular disease. All the patients had undergone conventional radiology (chest X-ray) and catheterization of the right heart cavities and pulmonary artery.

Results: we detected significantly elevated pulmonary artery pressures and resistances in the primary pulmonary hypertension group compared to secondary hypertension patients. Cardiac output values were much lower in the primary pulmonary hypertension individuals compared with secondary pulmonary hypertension in left-sided valvular disease. The pulmonary artery arch diameter, the diameter of the right descending pulmonary artery and the value of the arterio-bronchial ratio were similar in the two groups.

Conclusion: in both groups, we found a statistically significant positive correlation between the values of the pulmonary artery vascular resistance and the diameter of the right descending pulmonary artery, which are very specific parameters in the diagnosis of pulmonary hypertension. In the primary pulmonary hypertension group we identified a significant inverse correlation between the diameter of the right descending pulmonary artery and the values of cardiac output. This finding was not confirmed in the secondary group.

Key words: cardiac catheterization, conventional radiology, pulmonary arterial hypertension, cardiac output.

INTRODUCTION

Pulmonary arterial hypertension (PAH) is defined by a mean pulmonary artery pressure higher than 25 mm Hg at rest, and 30 mm Hg during effort. For the diagnosis of PPH, one must bear in mind and exclude all forms of SPH. Noninvasive imagery methods emerged nowadays, to help the clinician to diagnose and evaluate patients presenting with PAH. Doppler echocardiography, as well as other fast, safe and reliable examinations, is now considered an investigation of choice which has been included in the diagnostic protocol of PPH and SPH. In cases of suspected irreversible pulmonary hypertension a test with a vasodilator may be indicated. Other invasive techniques, incurring some risks, like right heart catheterization, have also been developed in recent years.

Although, actually, Doppler echocardiography is the technique of election to evaluate patients with primary or secondary pulmonary hypertension, in some cases, especially in smaller hospitals, less equipped and instated, conventional chest radiography remains a useful diagnostic test, which can sometimes be relevant to make a first clinical decision. This is why, the aim of our present study was to reappraise the accuracy, the value and the importance of conventional radiology data compared to right heart and pulmonary artery catheterization findings, in the diagnosis and follow-up of patients with PPH and SPH after left heart valve...
disease. We also tried to find some correlations between the radiologic parameters (which nowadays have a historical significance) and the invasive parameters (recently developed).

METHODS

Fourteen patients with PPH and twenty individuals diagnosed with SPH after left heart valve disease, admitted to our hospital during 1995-2006, were involved in the present retrospective study. In the PPH group there were 11 women and 3 men, with ages between 19-56 years (average age, 38 years), whereas the SPH group consisted of 10 women and 10 men with ages between 21-58 years, their average age being 44.52 years. All the patients in the SPH group had been diagnosed with mitral (mitral stenosis and mitral insufficiency) and aortic (aortic stenosis and aortic insufficiency) valve disease.

The radiological examination consisted in chest X-rays in postero-anterior, lateral, right anterior oblique and left anterior oblique projections. The indices used to quantify the degree of PAH were: the right descending pulmonary artery diameter (rdPAD); the arterio-bronchic index (ABi), rapporting rdPAD to the diameter of its corresponding bronchus; the height of pulmonary artery trunk on the left cardiac silhouette (pulmonary artery arch-PAa).

Right heart catheterization was performed with a flow-directed pulmonary artery catheter, introduced percutaneously via a left arm vein, and the systolic (sPAP), diastolic (dPAP), and mean (mPAP) pulmonary artery pressures were measured. The cardiac output (CO) and the pulmonary vascular resistance (PVR) were calculated as well, in both groups, by standard procedures.\textsuperscript{10, 11}

Values are presented as mean ± standard deviation, for the quantitative variables. The comparisons between groups were achieved using the t-test (student) for small groups, and a p value < 0.05 was considered statistically significant.

RESULTS

Catheterization data together with radiological findings are presented in Table 1. We recorded higher pulmonary artery and right ventricular pressures in the PPH group, compared to the SPH group. In the PPH group, sPAP was 92.07 +/- 4.30 mm Hg, dPAP = 34.64 +/- 2.05 mm Hg, mPAP = 56.21 +/- 3.32 mm Hg and respectively, 64.04 +/- 3.20 mm Hg, 30.19 +/- 1.95 mm

<table>
<thead>
<tr>
<th>Parameters</th>
<th>PPH (primary pulmonary hypertension)</th>
<th>SPH (secondary pulmonary hypertension in left heart valve disease)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of pts</td>
<td>14</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Average age (years)</td>
<td>38</td>
<td>44.52</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>women</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>men</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>sPAP (mmHg)</td>
<td>92.07 ± 4.30</td>
<td>64.04 ± 3.20</td>
<td>0.008 *</td>
</tr>
<tr>
<td>dPAP (mmHg)</td>
<td>34.64 ± 2.05</td>
<td>30.19 ± 1.95</td>
<td>0.044 *</td>
</tr>
<tr>
<td>mPAP (mmHg)</td>
<td>56.21 ± 3.32</td>
<td>42.76 ± 2.32</td>
<td>0.031 *</td>
</tr>
<tr>
<td>PVR (dyne x sec x cm(^{-5}))</td>
<td>998.36 ± 57.04</td>
<td>469.3 ± 37.04</td>
<td>0.003 *</td>
</tr>
<tr>
<td>CO (L/min/m(^{2}))</td>
<td>3.03</td>
<td>4.5</td>
<td>0.012 *</td>
</tr>
<tr>
<td>rdPAd (mm)</td>
<td>20.43 ± 0.82</td>
<td>21.09 ± 0.72</td>
<td>0.42 (NS)</td>
</tr>
<tr>
<td>PAa (mm)</td>
<td>55 ± 0.92</td>
<td>52.14 ± 0.74</td>
<td>0.22 (NS)</td>
</tr>
<tr>
<td>ABi</td>
<td>2.41 ± 0.09</td>
<td>2.17 ± 0.07</td>
<td>0.36 (NS)</td>
</tr>
</tbody>
</table>

* - statistically significant ; NS - not significant

Legend:
pulmonary artery pressures – PAP: systolic (sPAP), diastolic (dPAP), mean (mPAP);
pulmonary vascular resistance – PVR; cardiac output – CO;
right descending pulmonary artery diameter – rdPAd;
pulmonary artery arch diameter – PAa; arterio – bronchic index - ABi
Hg, 42.76 +/- 2.32 mm Hg, in the SPH patients (Figure 1). PVRs were much higher in the PPH group (998.36 +/- 57.04 dyne.sec.cm⁻⁵) compared to the SPH group (469.3 +/- 37.04 dyne.sec.cm⁻⁵). (Figure 3) Cardiac output was inferior in the first group (3.03 l/min/m²), compared to the second (4.5 l/min/m²). (Figure 4)

Concerning the radiological data, the rdPAD had similar values in both groups (20.43 +/- 0.82 mm for PPH, 21.09 +/- 0.72 mm for SPH) (Figure 2). Similar values were recorded also for the ABi (2.41 +/- 0.09, and 2.17 +/- 0.07 respectively). By using the linear regression method, we documented in both groups a significant positive correlation between rdPAD (measured on radiography films) and PVR, measured invasively. By applying the regression method, in the PPH group we found an r = 0.9088 (Table 2 and Table 3) and a p < 0.05, the equation being Y = 16.66 + 0.0037 X, Y representing the rdPAD and X the PVR. In the PPH group, in cases with PVR < 800 dyne.sec.cm⁻⁵, the rdPAD varied between 17-19 mm, whereas in cases with PVR > 800 dyne.sec.cm⁻⁵, rdPAD varied between 20-24 mm. In either group, we documented no significant correlation between the ABi or the PAa, on the one hand and the PVR, on the other. In either group, there also was no significant positive correlation between the rdPAD and the mPAp. Neither was there a correlation found between the diameter of the PAa and the mPAp. In the SPH group, we found a positive significant correlation between the values of the PVR, and the ABi (r = 0.546, p< 0.05) (Table 2 and Table 3). The patients with a ratio of pulmonary vascular resistances to systemic vascular resistances higher than 33% had an ABi above 2/1. In the PPH group, we documented a significant negative correlation between the rdPAD and the cardiac output (p<0.05).

**DISCUSSION**

The modern classification of pulmonary arterial hypertension (Venice 2003)¹² defines the following categories: proliferative arterial pulmonary hypertension, passive arterial pulmonary hypertension, hypoxic pulmonary arterial hypertension, and obstructive (embolic) pulmonary arterial hypertension. The cases

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*:PPH – primary pulmonary hypertension
*:SPH – pulmonary hypertension secondary to left heart valve disease

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**Figure 1.** The pulmonary arterial pressures (systolic-sPAP, diastolic-dPAP and mean-mPAP) in the two groups

**Figure 2.** The pulmonary artery diameters (pulmonary artery arch diameter-PAa and right descending pulmonary artery diameter-rdPAa) in the two groups

**Figure 3.** The pulmonary vascular resistances (PVR) in the two groups

**Figure 4.** The cardiac output (CO) in the two groups
we followed—up in this study belong to the first two categories. Primary or idiopathic arterial pulmonary hypertension is included in the proliferative category, together with the familial form, the pulmonary hypertension associated with connective tissue diseases, HIV infection, portal hypertension, congenital heart disease and drugs. The arterial pulmonary hypertension secondary to left heart valvular disease is included in the second category (passive arterial pulmonary hypertension).

Catheterization data

As expected, we recorded higher pulmonary artery and right ventricular pressures in the PPH group compared to the SPH group. The PVRs were also much higher in the first group, compared to the second. Both parameters are very important prognostic factors.\(^1\),\(^14\) Cardiac output was inferior in the PPH group, compared to the SPH group. This is a very important fact, since cardiac output is a major prognostic parameter in patients with primary arterial pulmonary hypertension.

Radiological Data

The rdPAD and the ABI had similar values in both groups. The PAA diameter was larger in the SPH patients, compared with the PPH patients, but the difference did not reach statistical significance.

Correlations Between Catheterization and Radiological Data

In both groups, we documented a significant positive correlation between the diameter of the right descending pulmonary artery and the pulmonary vascular resistance. Reuben and col.\(^15\) have shown that the pulmonary artery diameter is regulated not only by pulmonary vascular resistances and pulmonary artery pressures, but also by other parameters such as the compliance of the pulmonary artery wall, which is substantially reduced in pulmonary hypertension.\(^3\)

In both groups, rdPAD didn’t correlate significantly with the pulmonary artery pressures. This may be explained by the fact that in patients in whom the pulmonary artery pressures rise rapidly, there is no sufficient time for the pulmonary artery to dilate appropriately. Our results are concordant to those of O’Callaghan and col,\(^16\) but in disagreement with other computed tomography studies.\(^17\)

In patients with PPH, there was also a significant inverse correlation found between the diameter of the right descending pulmonary artery and the values of cardiac output.

CONCLUSION

We documented much higher pulmonary artery pressures, higher pulmonary vascular resistances, but lower cardiac output in patients with primary arterial pulmonary hypertension compared to patients with arterial pulmonary hypertension secondary to mitral and aortic valve diseases. In both groups, we found a significant positive correlation between the values of the pulmonary artery vascular resistances and the diameter of the right descending pulmonary artery. There was no significant correlation between pulmonary artery pressures and the size of the right descending pulmonary artery, the diameter of the pulmonary artery arch or the arterio–bronchic index.

REFERENCES


