The right ventricle under acute and chronic overload: early detection of right ventricular dysfunction
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DECREASED PLASMA NEUROHORMONES AND IMPROVED CARDIAC PERFORMANCE AFTER SURGICAL TREATMENT OF CHRONIC PULMONARY EMBOLISM

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The findings of this case report suggest that quantitative assessment of plasma neurohormones and MRI functional parameters in patients with right ventricular pressure overload due to chronic pulmonary embolism might be used as indicators for right ventricular function before and after intervention. Monitoring of changes in these parameters may provide quantitative follow up of RV function in these patients.
INTRODUCTION

Diagnosis of right ventricular (RV) dysfunction is difficult, but of great clinical importance in patients with (chronic) RV pressure overload due to pulmonary embolism (PE). A more accurate estimation of RV function in these patients might be useful in the determination of the optimal moment for medical or surgical intervention in order to prevent or delay irreversible RV failure.

Recently, neurohumoral activation of the RV in state of overload has gained increased attention. Brain natriuretic peptide (BNP) is a marker for ventricular dysfunction and is secreted in both atria and ventricles, especially in failing ventricles. We have recently demonstrated that levels of plasma neurohormones, BNP and atrial natriuretic peptide (ANP), were inversely correlated with RV ejection fraction (EF) in patients with chronic RV pressure overload due to congenital heart disease. However, the role of plasma neurohormones and their applicability in detection of RV dysfunction in patients with chronic pulmonary embolism are as yet unclear.

CASE REPORT

In August 1999, a 56-year-old man with known chronic pulmonary embolism since 1995 was referred because of gradually progressive dyspnea and a decline in his functional capabilities (NYHA class III-IV/IV). Ventilation-perfusion scintigraphy in 1995 showed multiple mismatched segmental defects with repeated studies in 1998 and 1999 being essentially unchanged. On admission, echocardiography demonstrated severe right atrial (RA) and RV enlargement; the tricuspid regurgitant envelope was 5.7 m/sec, suggesting a peak pulmonary artery systolic pressure (PAP) of approximately 140 mmHg. Cardiac MRI demonstrated severe RA and RV dilatation, RV hypertrophy and the interventricular septum bulging towards the LV (Figure 1A). RV EF was 44%, stroke volume being 62 ml/beat, LV EF was 74%. Plasma neurohumoral status of the patient revealed markedly increased concentrations of BNP, ANP and N-terminal-ANP; in addition, also the levels of other plasma neurohormones were increased (Table 1).

At heart catheterization, hemodynamic studies revealed a RA pressure of 7 mmHg, a RV pressure of 126/17 mmHg, a pulmonary arterial pressure of 126/34 with a mean pressure of 68 mmHg, a pulmonary capillary wedge pressure of 9 mmHg, and a cardiac output of 2.7 L/min. Pulmonary vascular resistance was 1748 dynes/sec/cm-5. Pulmonary angiography revealed evidence of bilateral, surgically-accessible, chronic thromboembolic disease.

Given his significant pulmonary hypertension in the setting of progressive functional disability, and with the chronic thrombemboli surgically accessible, a pulmonary thromboendarterectomy (PTE) was performed. The surgery resulted in significant hemodynamic improvement. Two months postoperatively the functional status of the patient was estimated to be NYHA classification I/IV, and plasma neurohumoral status (Table 1) and cardiac MRI were repeated (Figure 1B).

Plasma neurohormone levels after PTE decreased significantly (Table 1). The RV SV had increased from 62 ml to 76 ml/beat, RV EF from 44% to 59%, the interventricular septum regained its normal shape, LV EDV rose from 87 ml prior to PTE, to 110 ml after PTE. Echocardiography has confirmed improved bi-ventricular function; systolic PAP was estimated to be 65 mmHg.
**DISCUSSION**

The most widely used tool in clinical practice for the diagnosis and follow-up of RV dysfunction is echocardiography. As demonstrated before both by catheterization\(^4\) and echocardiography\(^5\), PTE in general results in a significant and rapid decline in RV afterload associated with a marked improvement in the functional status of the patients. For long-term post-operative follow-up of RV function in these patients, however, repeated catheterization is not a useful tool. Also the value of echocardiography seems limited in this respect due to its technical limitation (acoustic window), and the absence of a reliable mathematical assumption due to complex geometry of RV. Regarding these limitations, quantitative diagnostic parameters, like plasma neurohormones and MRI, might be helpful in elucidating the RV function in patients with chronic PE, both before and after PTE surgery.

The potential prognostic value of BNP has been underscored in previous studies regarding RV as well as LV pathology\(^2,3\). In chronic RV pressure overload, plasma BNP levels are considered to reflect RV dysfunction rather than RV pressure. In patients with pulmonary hypertension due to volume or pressure overload, plasma BNP levels were demonstrated by Nagaya et al\(^1\) to increase in proportion to the extent of RV dysfunction. These observations are consistent with our recently reported studies\(^6\).

### Quantitative Parameters of Right Ventricular Function

<table>
<thead>
<tr>
<th></th>
<th>Before PTE</th>
<th>After PTE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plasma neurohumoral factors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BNP (pmol/L)</td>
<td>99.0</td>
<td>3.3 (-97%)</td>
</tr>
<tr>
<td>ANP (pmol/L)</td>
<td>51.9</td>
<td>2.7 (-95%)</td>
</tr>
<tr>
<td>Nt-ANP (nmol/L)</td>
<td>2.391</td>
<td>0.552 (-77%)</td>
</tr>
<tr>
<td>Noradrenaline (pg/ml)</td>
<td>513</td>
<td>273 (-47%)</td>
</tr>
<tr>
<td>Adrenaline (pg/ml)</td>
<td>24</td>
<td>12 (-50%)</td>
</tr>
<tr>
<td>Dopamine (pg/ml)</td>
<td>10</td>
<td>13 (+30%)</td>
</tr>
<tr>
<td>Aldosterone (pg/ml)</td>
<td>33</td>
<td>21 (-36%)</td>
</tr>
<tr>
<td>Endothelin (pg/ml)</td>
<td>15.2</td>
<td>11.7 (-23%)</td>
</tr>
<tr>
<td>SSAO (mU/L)</td>
<td>773</td>
<td>674 (-13%)</td>
</tr>
</tbody>
</table>
Table 1. Data are presented as value (% change) ANP = atrial natriuretic peptide; BNP = brain natriuretic peptide; EDV = end-diastolic volume; EF = ejection fraction; ESV = end-systolic volume; Nt-ANP = N-terminal pro atrial natriuretic peptide; PTE = pulmonary thromboendarterectomy; SSAO = semicarbazide-sensitive amine oxidase; SV = stroke volume.

CONCLUSION

This case report suggests that the increased secretion of plasma neurohormones, and BNP and ANP in particular, corresponds to RV function in patients with chronic PE. If our results can be confirmed with larger numbers of patients, plasma levels of neurohormones may be of clinical importance as a supplementary tool for the quantitative assessment of RV function under circumstances of chronic RV pressure overload. This may be of considerable importance in the diagnostic process, timing of treatment and possibly also post-operative prognosis of patients with RV overload due to chronic PE.

Figure 1. End-diastolic mid-ventricular MRI image; (A) before and (B) after pulmonary thromboendarterectomy. RV = Right Ventricle; LV = Left Ventricle.
REFERENCES


