THE VALUE OF FORCED INSPIROGRAM FOR ESTIMATING REVERSIBILITY OF VENTILATORY IMPAIRMENT IN CHRONIC OBSTRUCTIVE LUNG DISEASE

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In sixty patients with chronic obstructive lung disease the sensitivity of FEV₁ was compared with the sensitivity of FIV₁ in assessing the reversibility of ventilatory impairment. The FEV₁/FIV₁ ratio before and after administration of adrenaline was analyzed. The decrease of this ratio after adrenaline was considered as the index of better sensitivity of FIV₁ whereas the increase of this ratio was considered as the index of equal or better sensitivity of FEV₁. In 67% of cases the ratio decreased. In addition to forced expirogram the forced inspirrogram i.e. FIV₁ is therefore recommended as a useful test in estimating ventilatory effect of bronchodilators and other antiasthmatic drugs in patients with chronic obstructive lung disease.

Forced inspirrogram has not been frequently used as a routine test in assessing the ventilatory impairment. Comroe and coworkers (1) have recommended the comparison of forced expirogram and forced inspirrogram as a useful procedure in discriminating expiratory and inspiratory difficulties. Other authors (2-4) have suggested that ratio of one second forced expiratory volume to one second forced inspiratory volume (FEV₁/FIV₁) or the ratio of maximum expiratory flow rate to maximum inspiratory flow rate (MEFR/MIFR) may be helpful in distinguishing asthma from emphysema. The lower ratio should indicate the presence of an increased expiratory resistance (emphysema) and higher ratio the presence of both increased expiratory and inspiratory resistance (asthma). Chapman (5) however, has analysed FEV₁/FIV₁ ratio in a large number of patients with asthma and emphysema and found that this ratio is of doubtful val-

* The study was carried out in the Hospital for Allergic Respiratory Diseases in Dubrovnik.
ue in distinguishing the two diseases, Jordanoglou and Pride (6) have studied the maximum effort flow-volume curves, both expiratory and inspiratory, of subjects with asthma and emphysema. They have found a low MEFR/MIFR ratio at the point of 50% of vital capacity, and concluded that this ratio does not help in distinguishing a patient with asthma from one with emphysema.

The sensitivity of forced inspirogram as compared to forced expirogram in assessing the reversibility of ventilatory impairment has not been thoroughly analyzed. In the studies of Simonsson (2) and Segarra and coworkers (7) one can see that in certain patients with chronic obstructive lung disease FIV₁ seems to be a more sensitive index of reversibility of ventilatory impairment than FEV₁. Stimulated by these data and also by the observation that patients with chronic obstructive lung disease may show symptomatic improvement after administration of bronchodilators and other antiasthmatic drugs without a measurable ventilatory response in forced expirogram, I have analyzed the FEV₁/FIV₁ ratio in these patients before and after administration of adrenaline in order to compare the sensitivity of the two volumes in assessing the reversibility of ventilatory impairment.

METHOD

A group of 60 patients with chronic obstructive lung disease aged over 40 was selected. One second forced expiratory volume did not exceed 1500 ml and was below 50% of the observed vital capacity. Cardiovascular and other chest diseases with the symptoms similar to those of chronic obstructive lung disease were excluded by clinical, radiological and electrocardiographic examination.

The patients were told about the purpose of the examination and instructed in the technique of breathing during the testing. On the Pulmofast Godart forced expirogram and forced inspirogram were registered at the highest speed of kinograph. Forced expirogram was performed after a maximal inspiration while forced inspirogram followed a maximal slow expiration. Both tests were done before and 20 minutes after subcutaneous administration of adrenaline (1:1000) in amounts of 0.5 ml and repeated 3–4 times in order to make the values as reliable as possible. From the spiographic tracings FEV₁ and FIV₁ were read out and the FEV₁/FIV₁ ratio was calculated. The decrease of this ratio after adrenaline was considered as the index of better sensitivity of FIV₁, whereas the increase of this ratio was considered as the index of equal or better sensitivity of FEV₁ in estimating the reversibility of ventilatory impairment.

In order to avoid inaccuracies commonly seen at the beginning of forced expirogram the steepest portion of the curve was extrapolated on the baseline and one second was calculated from this intersection. The performance of forced inspirogram always lasted more than one second.
RESULTS

Before the administration of adrenaline the mean FEV$_1$ was almost twice lower than the mean FIV$_1$. The mean FEV$_1$/FIV$_1$ ratio was 0.55. After adrenaline this ratio slightly decreased (Table 1).

Table 1

<table>
<thead>
<tr>
<th></th>
<th>Before Adrenaline</th>
<th>After Adrenaline</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>SD</td>
</tr>
<tr>
<td>FEV$_1$ (ccm)</td>
<td>910</td>
<td>361</td>
</tr>
<tr>
<td>FIV$_1$ (ccm)</td>
<td>1684</td>
<td>615</td>
</tr>
<tr>
<td>FEV$_1$/FIV$_1$ ratio</td>
<td>0.55</td>
<td>0.19</td>
</tr>
</tbody>
</table>

As seen from Table 2 in a considerable number of patients (67%) the FEV$_1$/FIV$_1$ ratio decreased indicating that FIV$_1$ was a more sensitive index of the reversibility of ventilatory impairment than FEV$_1$.

Table 2

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased ratio</td>
<td>20</td>
<td>33.3</td>
</tr>
<tr>
<td>Decreased ratio</td>
<td>40</td>
<td>66.7</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 3

Mean FEV$_1$/FIV$_1$ ratio before Adrenaline in two groups of patients

<table>
<thead>
<tr>
<th></th>
<th>Patients with increased ratio N=90</th>
<th>Patients with decreased ratio N=40</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>SD</td>
</tr>
<tr>
<td>FEV$_1$/FIV$_1$ ratio</td>
<td>0.49*</td>
<td>0.15</td>
</tr>
</tbody>
</table>

* The difference is statistically significant (P < 0.05)
The mean FEV₁/FIV₁ ratio before adrenaline was higher in these patients than in others, suggesting the presence of a more pronounced increase of inspiratory resistance. The difference was statistically significant (Table 3).

**DISCUSSION**

The results clearly show that in certain patients with increased respiratory resistance, both expiratory and inspiratory, the improvement of ventilatory function after administration of bronchodilators can be better demonstrated using forced inspirrogram than forced expirogram. Providing that a maximal effort was performed during the testing the higher increase of FIV₁ following administration of adrenaline indicates that the inspiratory resistance was more reversible than the expiratory resistance. This could be explained by the presence of bronchial collapse as an irreversible component of expiratory airway resistance but also by a possible increase of pulmonary compliance — a change which enhances inspiratory flow. These assumptions, however, remain to be proved.

**CONCLUSION**

In certain patients with chronic obstructive lung disease forced inspirrogram appears to be a more sensitive test for assessing the reversibility of ventilatory impairment. In addition to forced expirogram, forced inspirrogram i. e. FIV₁ should therefore be routinely used in estimating ventilatory effect of bronchodilators and other antiasthmatic drugs in patients with chronic obstructive lung disease.

**References**

7. Segarra, J., Gochi, J. C., Presas, F. M.: Medicina y Seguridad del Trabajo, 16 (1968) 44.
Sadržaj

VRIJEDNOST FORSIRANOG INSPIROGRAMA ZA PROCJENU REVERZIBILNOSTI VENTILACIJSKOG POREMECAJA U KRONIČNOJ OPSTRUKTIVNOJ BOLESTI PLUĆA

U šezdeset bolesnika s kroničnom opuštenom bolesti pluća uspoređena je osjetljivost volumena u prvoj sekundi forsirane ekspiracije (FEV₁) i volumena u prvoj sekundi forsirane inspiracije (FIV₁) u prošireni reverzibilnosti ventilacijskog poremećaja. Analiziran je odnos FEV₁ prema FIV₁ prije i poslije potkućno primjene adrenalina. Pad ovog odnosa poslije adrenalina uzet je kao indeks za bolju osjetljivost FIV₁, a porast kao indeks za bolji odnos FEV₁ prema FIV₁. U 67% slučajeva odnos FEV₁ prema FIV₁ je pao, pa je stoga za procjenu ventilacijskog učinka bronbhidilatora i drugih antistamičkih lijekova u bolesnika s kroničnom opuštenom bolesti pluća propušten forsiran inspirogram, tj. FIV₁ kao koristan dopunski test forsiranom ekspirogramu.

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