Does negative expiratory pressure (NEP) during spontaneous breathing predict respiratory impairment in elderly?

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Summary Objective: The purpose of this study is to assess whether expiratory flow limitation (FL), as measured by applying a negative pressure at the mouth during tidal expiration, can evaluate the respiratory impairment in elderly patients.

Methods: The study was carried out in 67 consecutive elderly inpatients (24 men and 43 women). Negative expiratory pressure (NEP) of \(-5\) (NEP 5) and \(-10\) (NEP 10) \text{cm} H\textsubscript{2}O were applied during spontaneous tidal expiration. According to the results of the NEP technique, the patients were stratified in two categories: not flow limited and flow limited. We realized then classic forced expiratory manoeuvres (FEV\textsubscript{1}, FVC) and clinical evaluation of dyspnea (NYHA). According to the values of the lung function data, elderly patients were then divided in 3 groups (normal, obstructive, restrictive).

Results: The sensitivity, the specificity, the positive and negative predictive values for the diagnosis of obstructive syndrome by the presence of flow limitation during NEP 5 were 53, 74, 45, 79\% respectively and 58, 83, 58, 83\% respectively during NEP 10. These findings show that the correlation between FL obtained by the NEP technique during spontaneous breathing and spirometry is not very good despite the fact that both were well correlated with dyspnea score.

Conclusions: In clinical practice, faced with an elderly dyspneic patient unable to perform maximal expiratory manoeuvres, the evaluation of flow limitation by NEP technique seems nor to be reliable to predict an obstructive functional impairment nor to be able to explain the origin of his dyspnea.

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Introduction

In the geriatric patient group, motor and sensory deficits, dementia, depression, bad learning...
capacity and dexterity negatively influence the measurement of spirometry. The negative expiratory pressure (NEP) provides a simple, non-invasive method for detection of flow limitation in spontaneously breathing non-cooperative patients, and preliminary results have shown that it can be used easily in elderly patients who were unable to perform a simple spirometry. The purpose of this study is to assess whether expiratory flow limitation (FL), as measured by NEP during spontaneous tidal expiration, is a good reflection of respiratory impairment of elderly patients compared with the values of FEV1 and FVC and with the clinical evaluation of dyspnea.

Materials and methods

The study was carried out in 67 consecutive elderly (≥75 years old) inpatients (24 men and 43 women) with and without complaint of dyspnea. All were recruited from the geriatric ward of the Mont-Godinne Hospital and were able to perform satisfactorily a simple spirometric test. Anthropometric characteristics and lung data are given in Table 1. The study was approved by the institutional ethics Committee.

NEP technique

Mouthpiece was connected with a pneumotachograph and a circular Venturi device able to generate a negative pressure during expiration (NEP 050, Medisoft, Dinant, Belgium) that was set to produce a negative airway pressure of −5 (NEP 5) or −10 (NEP 10) cm H2O during the expiration phase of resting stable breathing. Patients were studied sitting comfortably on a chair and wearing noseclips, and had their false teeth; NEP procedure was performed every five respiratory cycles. The response to NEP was analyzed by comparing the expiratory V’ – V curve of a control tidal expiration with that obtained during the subsequent expiration in which NEP was applied. Subjects in whom application of NEP did not show any increase of flow over a significant part (≥30%) of the whole control range of tidal volume (Vt) were considered as flow limited (FL). Conversely, subjects with increase of the control Vt during NEP were considered as not flow limited (NFL). The FL portion of the tidal expiration was expressed as percentage of the control Vt (%Vt) and ranged from 30% to 90% Vt in FL patients but all NFL patients had no limitation at all.

Pulmonary function testing

Subjects were instructed about the FVC manoeuvre according to the ATS standard, and the appropriate technique was demonstrated several times if necessary just before testing. Each participant was asked to perform forced expiratory manoeuvre in a effort to obtain three acceptable manoeuvres. The largest FEV1 and FVC, corrected to BTPS, were converted to percentage of predicted values. Acceptability was defined using ATS guidelines. For interpretation of the results, they were divided in three groups according to the lung function data: patients with a FEV1 higher than 80% of predicted values were considered as normal; those with a FEV1 lower than 80% and with an FEV1/FVC lower than 70% were considered as obstructive; patients with a FVC and a FEV1 lower than 80% but with a FEV1/FVC higher than 70% were considered as restrictive. Dyspnea was clinically evaluated by using the New York Heart Association (NYHA) score. Results are presented as % of predicted values or % of baseline values and expressed as mean ± SD. Sensitivity, specificity, positive and negative predicted values are given with 95% confidence intervals based on F distribution and were computed among the whole population. Correlation was assessed by Spearman’s rank coefficient.

Results

With NEP 5, among 67 patients, 44 were NFL, one had non-interpretable curves and 22 were FL. Anthropometric variables, mean spirometric results and dyspnea score of each category are shown in Table 1. Although most of the patients who were flow limited had significantly lower FEV1 (table) and although a negative correlation can be found between values of FEV1 and the mean flow.

<table>
<thead>
<tr>
<th>NFL (44)</th>
<th>FL (22)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (F/M)</td>
<td>29/15</td>
<td>13/9</td>
</tr>
<tr>
<td>Age (year)</td>
<td>80±4</td>
<td>83±5</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>163±7</td>
<td>161±6</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>67±9</td>
<td>66±13</td>
</tr>
<tr>
<td>FEV1 (%pred values)</td>
<td>89±25</td>
<td>67±31</td>
</tr>
<tr>
<td>FVC (%pred values)</td>
<td>88±26</td>
<td>81±23</td>
</tr>
<tr>
<td>FEV1/FVC</td>
<td>75±13</td>
<td>62±20</td>
</tr>
<tr>
<td>Dyspnea score</td>
<td>1.3±1.5</td>
<td>2.1±1.5</td>
</tr>
</tbody>
</table>
limitation of all subjects \( r = -0.356, \ P = 0.004 \), there was a considerable overlap of the data (Fig. 1). There is a fairly good negative correlation between FEV\(_1\) and dyspnea score \( r = 0.457, \ P < 0.001 \), and a positive correlation between the degree of flow limitation and dyspnea score \( r = 0.254, \ P = 0.041 \).

Among the 22 FL patients, six had a normal spirometry (FEV\(_1\) \( \geq 80\% \)), 10 were obstructive and six were restrictive. Mean flow limitation was 62 ± 13% of the \( V_t \). From the six FL patients with normal FEV\(_1\), two only were dyspneic.

Among the 44 NFL patients, 27 were normal, 10 obstructive and seven showed a restrictive syndrome. Among the 10 obstructive ones, two had FEV\(_1\) ≤ 35% showing a very severe ventilatory impairment.

The sensitivity for the diagnosis of obstructive syndrome by the presence of flow limitation during NEP 5 was 53% (29–76), specificity 74% (59–86), positive predictive value (PPV) 45% (24–68) and negative predictive value (NPV) 79% (64–90).

With NEP 10, 48 were NFL and 19 were FL. Five patients (four normal, one restrictive) who seemed FL during NEP 5 became NFL with NEP 10 and two NFL patients (one normal and one obstructive) became FL. The obstructive patient who had non-interpretable curves during NEP 5 was FL. Mean flow limitation was 64 ± 12% of \( V_t \). A positive correlation is observed between the flow limitation and dyspnea score \( r = 0.323, \ P = 0.008 \), and a negative one between FEV\(_1\) and mean flow limitation \( r = -0.483, \ P < 0.001 \). The sensitivity for the diagnosis of obstructive syndrome by the presence of flow limitation during NEP 10 was 58% (33–80), specificity 83% (69–92), PPV 58% (33–80) and NPV 83% (69–92).

Patients with a high dyspnea score (\( \geq 2 \)) were more often flow limited than those with a low score (\( < 2 \)) at both NEP 5 (\( P = 0.029 \)) and NEP 10 (\( P = 0.011 \)). No difference was observed between both sexes.

**Discussion**

The assessment of pulmonary function in the elderly population is not often easy in clinical practice because of patients' bad collaboration. In former studies, 12–40% patients older than 65 years could not perform three acceptable forced expiratory manoeuvres and had lower scores in psychomotor speed and executive function tests.\(^2,6,7\) NEP technique can be easily applied to non-cooperative patients and in any position, and has been successfully used by our group in these not cooperating elderly patients.\(^2\) In obstructive flow-limited subjects, the use of NEP should not increase the available expiratory flow,\(^1\) but NEP results may be influenced by the upper airways mechanics: false positivity of flow limitation during NEP is possible especially if the upper airways collapse when the negative pressure is too strong. In our study, we used low pressures of \(-5\) and \(-10\) cm H\(_2\)O and patients kept their false teeth: the pressure required to produce collapse in patients with obstructive sleep apneas (who already have a high probability to collapse the upper airways) range from \(-11\) to \(-40\) cm H\(_2\)O.\(^8\)

Several recent studies showed nevertheless that NEP 5 or 10 can induce upper airway collapse and "false positive" expiratory flow limitation;\(^9-11\) so, this artifact can be important particularly in an elderly population and may contribute to explain why many "normal" or "restrictive patients" were flow limited in our study.

NEP technique has been used to detect flow limitation during spontaneous breathing in COPD patients,\(^3\) patients with stable asthma\(^12\) and children\(^13\) but its role for evaluating lung function in elderly population is not yet known. According to our study, the flow limitation obtained by NEP technique cannot predict very well the impairment of FEV\(_1\) and consequently the diagnosis of obstructive airways syndrome by measuring FL during tidal expiration is not reliable in elderly patients: a subject in whom flow limitation is detected with the NEP 5 technique has a probability of 45% only to
have an obstructive syndrome in spirometry and conversely, if he has no flow limitation, the probability not to have an obstructive syndrome is 79% only. This low specificity of FL is due to the fact that some NFL patients had in fact a severe impairment of FEV₁, and that some FL subjects had no FEV₁ impairment at all. Whether expiratory flow limitation will or not occur depends on three major factors, namely the end-expiratory lung volume, the level of ventilation and the maximum expiratory flow volume envelope prevailing at that lung volume. Because these three factors can vary independently from one another in a general population of elderly patients, a weak association must be found between the NEP test and FEV₁ because no control can be exercised over two of the independent variables. In a clinical setting where the application of this test is intended, it would be very difficult indeed to control the three variables simultaneously. Therefore, the utility of the NEP test in predicting airways obstruction in elderly patients is questionable.

There was nevertheless a good correlation between dyspnea score and both indices despite the fact that NYHA score evaluates dyspnea according to effort tolerance and that NEP was performed in rest condition. The subjective feeling of dyspnea can indeed be caused by various pathophysiological mechanisms that influence differently FL and FEV₁.³

To conclude, in the clinical practice, when faced with a dyspneic elderly patient unable to perform maximal expiratory manoeuvres, the evaluation of flow limitation by the NEP technique seems nor to be reliable to predict an obstructive functional impairment nor to be able to explain the origin of the dyspnea.

Acknowledgements

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References