Structured light plethysmography to evaluate the effects of acute bronchodilation during tidal breathing in COPD patients

Pierantonio Laveneziana1,2,3, Rachel Wilson*, Claudia Llontop3, Marie-Cecile Nierat1,2, Christian Straus1,2,3, Thomas Similowski1,2,4

1 Sorbonne Universités, UPMC Université Paris 06, UMRS 1158, Neurophysiologie Respiratoire Expérimentale et Clinique, Paris, France; 2 BREA, UMR 5156, Neurophysiologie Respiratoire Expérimentale et Clinique, Paris, France; 3 AP-HP, Groupe Hospitalier Pitò-Salpêtrière Charles Foix, Service des Explorations Fonctionnelles de la Respiration, de l'Exercice et de la Dynamique, Paris, France; 4 AP-HP, Groupe Hospitalier Pitò-Salpêtrière Charles Foix, Service de Pneumologie et Rénalisation Médicamente, Paris, France; 5 Pitié-Salpêtrière, Paris

Abstract

Rationale: The effects of bronchodilators (BD) are traditionally assessed using forced respiratory maneuvers. Real-life evaluation of BDs is desirable. Structured light plethysmography (SLP) is a non-contact method of assessment of breathing pattern during tidal breathing using SLP (Thoradi TM, Pneumacare, UK) to evaluate the effects of BD on breathing mathematical biomarkers in COPD patients.

Methods: Measurements were taken during tidal breathing, pre and 5 minutes post short-acting BD in 16 patients (11M, 80±6yrs, BMI=25±4, mean post-BD FEV1=65±21% predicted). The relative (%) contribution of Thorax (T) and Abdomen (A), the T/A phase and the Konno-Mead angle (KM) were recorded. We also measured inspiratory capacity (IC), using a pneumotachograph and patient dyspnoea using the visual analog scale. (D-VAS).

Results: After BD 11 patients showed an increase in IC >150ml and the following tidal breathing variables changed: T/A phase -3.4% (p<0.05), relative T -6%, p=0.02). A contribution %, IC = 6.5 (p=0.05), D-VAS score change (-5.0±VAS-2.9m). In 5 patients no significant changes were seen.

Conclusions: SLP detected a change in T/A contribution in tidal breathing in COPD patients who deflated their lungs (increase in IC) after BD. This pattern may suggest a more efficient contribution of the diaphragm to tidal breathing in this subgroup of COPD patients after BD. This preliminary data suggest that SLP-related breathing pattern analysis during resting quiet breathing predicts the perceptual and volume response to bronchodilator.

Background

➢ The effects of bronchodilators (BD) are traditionally assessed using forced respiratory maneuvers.
➢ Real-life (i.e., during tidal breathing) evaluation of BDs is desirable.
➢ One major difficulty when studying tidal breathing comes from the so-called "observer effect".
➢ Likewise, using a mouthpiece and a nose clip to measure ventilatory flow with a pneumotachograph introduces a major perturbation to breathing (probably because it "unanges" respiratory sensations that are normally filtered out by the brain) and therefore constitutes a stimulus that modifies the respiratory behaviour.

Objectives

➢ The purpose of the current study was to evaluate the effects of short-acting bronchodilators (BDs) on breathing pattern, thoraco-abdominal contribution and dyspnoea during resting quiet breathing in COPD patients using Structured Light Plethysmography (SLP, Thoradi TM, Pneumacare, UK), a new non-contact method of assessment of breathing pattern during tidal breathing.

Methods

➢ Stable COPD patients undergoing Pulmonary Function Testing (PFT) pre and post administration of short acting BD, with normal BMI and with no evidence of a restrictive ventilatory defect (TLC<65% of the predicted value, ERS/ATS Guidelines 2005).
➢ SLP measures pre and 5 minutes post short-acting BD:
  o the relative (%) contribution of Thorax (T) and Abdomen (A),
  o the T/A phase
  o the Konno-Mead angle (KM angle)
➢ Inspiratory capacity (IC) and patient’ dyspnoea intensity changes (visual analog scale, D-VAS) pre and post short-acting BD.

Health technologies being assessed

➢ Thora 3D ™ the new technology being assessed, provides real time rapid non-contact assessment of lung function utilising structured light technology and advanced imaging processing. This technology utilises SLP (Structured Light Plethysmography) and can be performed while sitting in a chair or at supine in bed. In summary
  ➢ Structured light is projected on to the patient’s chest
  ➢ Camera film the movement of the grid over time
  ➢ Software utilises video to create 3D view of chest movement and calculates volume of air moved
  ➢ Output is delivered in 3D regional output on the user interface

Deflators (n=11) vs Non-deflators (n=5)

<table>
<thead>
<tr>
<th></th>
<th>Deflators (n=11)</th>
<th>Non-deflators (n=5)</th>
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<tbody>
<tr>
<td></td>
<td>pre-BD (mean ± SD)</td>
<td>post-BD (mean ± SD)</td>
</tr>
<tr>
<td>Age, yrs</td>
<td>67 ± 5</td>
<td>68 ± 6</td>
</tr>
<tr>
<td>Sex, M/F</td>
<td>6/5</td>
<td>5/0</td>
</tr>
<tr>
<td>BMI</td>
<td>25 ± 4</td>
<td>25 ± 5</td>
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<tr>
<td>FEV1, L</td>
<td>1.4 ± 0.4</td>
<td>1.5 ± 0.5*</td>
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<tr>
<td>FEV1 % predicted</td>
<td>61 ± 18</td>
<td>65 ± 21</td>
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<tr>
<td>IC, L</td>
<td>2.3 ± 6.6</td>
<td>2.7 ± 0.5*</td>
</tr>
<tr>
<td>D-VAS, cm</td>
<td>3.5 ± 0.9</td>
<td>1.5 ± 0.5&lt;sup&gt;*&lt;/sup&gt;</td>
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<tr>
<td>T cont%, %</td>
<td>51 ± 11* (n=11)</td>
<td>49 ± 12*</td>
</tr>
<tr>
<td>A cont%, %</td>
<td>49 ± 11* (n=11)</td>
<td>51 ± 12</td>
</tr>
<tr>
<td>T/A phase</td>
<td>8.7 ± 6.0</td>
<td>8.8 ± 6.1</td>
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<tr>
<td>KM angle</td>
<td>2.7 ± 12.8&lt;sup&gt;3&lt;/sup&gt; (n=11)</td>
<td>0.4 ± 13.2&lt;sup&gt;3&lt;/sup&gt;</td>
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</table>

<sup>1</sup>= pre vs post; <sup>3</sup>= deflators vs non-deflators

Conclusions

➢ SLP detected a change in T/A contribution in tidal breathing in COPD patients who deflated their lungs (increase in IC) after BD.
➢ This pattern may suggest a more efficient contribution of the diaphragm to tidal breathing in this subgroup of COPD patients after BD. This preliminary data suggest that SLP-related breathing pattern analysis during resting quiet breathing predicts the perceptual and volume response to bronchodilator.