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

Pierantonio Laveneziana[1,2,3], Rachel Wilson*, Claudia Llontop[3], Marie-Cecile Nierat[1,2], Christian Straus[1,2,3], Thomas Similowski[1,2,4]

[1]Sorbonne Universités, UPMC Université Paris 06, UMR_S 1158, Neurophysiologie Respiratoire Expérimentale et Clinique, Paris, France; [2]INSERM, UMR_S 1158, Neurophysiologie Respiratoire Expérimentale et Clinique, Paris, France; [3]AP-HP, Groupe Hospitalier Pitié-Salpêtrière Charles Foix, Service des Explorations Fonctionnelles de la Respiration, de l'Exercice et de la Dyspnée, Paris, France; [4]AP-HP, Groupe Hospitalier Pitié-Salpêtrière Charles Foix, Service de Pneumologie et Réanimation Médicale, Paris, France; *Pneumacare, UK

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. We used SLP (Thora3Di 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, 68±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), relativeT -6 %, p<0.05), A contribution + 6%, (p<0.05), KM + 1.6 (p<0.05). D-VAS score changed (ΔD-VAS=2cm). 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, which was not observed in those COPD who did not recruit IC 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 "ungates" 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, Thora3Di TM, Pneumacare, UK), a new non-contact method of assessment of breathing pattern during tidal breathing.

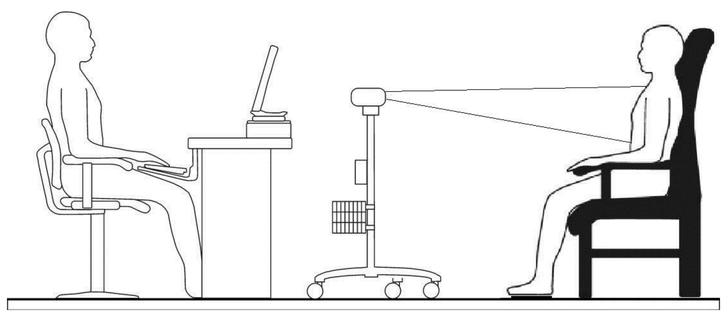
Methods

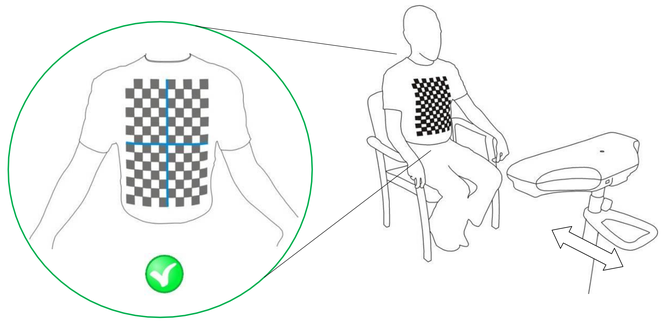
- Stable COPD patients undergoing Pulmonary Function Testing (PFT) pre and post administration of short acting BD, with normal BMI and with no evidence of a restrictive ventilatory defect (TLC <5th percentile of the predicted value, ERS/ATS Guidelines 2005).
- SLP measures pre and 5 minutes post short-acting BD:
  - the relative (%) contribution of Thorax (T) and Abdomen (A),
  - the T/A phase
  - 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

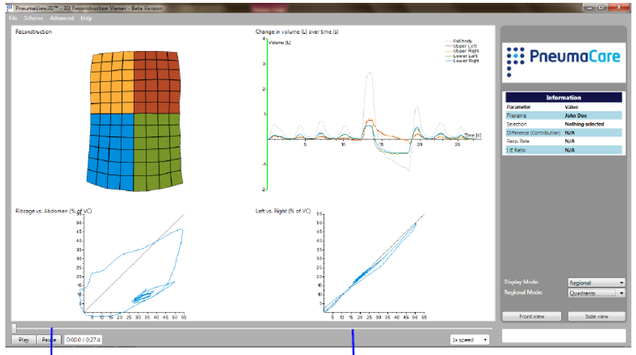
Thora 3D ™ the new technology being assessed, provides real time rapid non-contact assessment of lung function utilising structured light technology and advanced imaging processing. This technologyutilises SLP (Structured Light Plethysmography) and can be performed while sitting in a chair or at supine in bed. In summary

- Structured light is projected on to the patient's chest
- Cameras 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)



	Deflators (n = 11)		Non-deflators (n = 5)	
	pre-BD (mean ± SD)	post-BD (mean ± SD)	pre-BD (mean ± SD)	post-BD (mean ± SD)
Age, yrs	67 ± 6		68 ± 6	
Sex, M/F	6/5		5/0	
BMI	25 ± 4		25 ± 5	
FEV_1, L	1.4 ± 0.4	1.5 ± 0.5*	1.9 ± 0.9	2.0 ± 1.0
FEV_1, % predicted	61 ± 18	65 ± 21*	63 ± 23	66 ± 25
IC, L	2.3 ± 0.6	2.7 ± 0.5*	3.3 ± 1.1	3.2 ± 1.0
D-VAS, cm	3.5 ± 0.9	1.5 ± 0.5*$	3.4 ± 0.9	2.8 ± 0.4
T contr, %	51 ± 11$ (p=0.048)	49 ± 12*	39 ± 9	36 ± 16
A contr, %	49 ± 11$ (p=0.048)	51 ± 12	61 ± 9	64 ± 16
T/A phase	8.7 ± 6.0	8.8 ± 6.1*	7.7 ± 5.7	10.7 ± 6.3
KM angle	2.7 ± 12.8$ (p=0.045)	0.4 ± 13.2*	-11.6 ± 10.8	-13.5 ± 19.2

* = pre vs post; $ = 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, which was not observed in those COPD who did not recruit IC after BD.
- This preliminary data suggest that SLP-related breathing pattern analysis during resting quiet breathing predicts the perceptual and volume response to bronchodilators.