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SHORT COMMUNICATION

Use of a portable device to record maximum inspiratory flow in relation to dyspnoea in patients with COPD☆

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Summary
Forced inspiratory measures have been described to reflect the reduction in dyspnoea upon bronchodilation in severe COPD. Based on this we evaluated the applicability and usefulness of a portable device for the assessment of forced inspiration. In 37 patients with COPD (GOLD II/III/IV $n = 16/15/6$, mean ± SD FEV_1 46.2 ± 15.4%pred) lung function was recorded prior to inhalation of 24 μg formoterol and 30 min later. Assessments comprised spirometry including forced inspiration, body plethysmography, maximum inspiratory flow (InCheck, Clement Clarke), and changes in dyspnoea via visual analogue scale (VAS). The sequence was repeated on a second day to assess reproducibility. Bronchodilation by formoterol was detectable in all functional indices ($p < 0.05$ each) except total lung capacity. FEV_1 improved by (mean ± SD) 11.1 ± 10.3%, forced inspiratory volume in 1s (FIV_1) by 11.6 ± 13.5%, inspiratory peak flow (PIF) by 10.7 ± 16.2%, and inspiratory flow determined by the InCheck device (IF-IC) by 11.9 ± 14.4%. Remarkably, the changes of IF-IC ($p < 0.001$) but not those of other measures except FIV_1 ($p < 0.05$) were related to those of dyspnoea. Effects on IF-IC showed reproducibility comparable to that of other indices. The results suggest that a simple, portable device for recording forced inspiration could be useful in monitoring COPD, as a functional correlate of acute changes in dyspnoea. (ClinicalTrial.gov number NCT00561886).

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Introduction

The association between clinical state and lung function in patients with chronic obstructive pulmonary disease (COPD) is known to be far from simple. Among other observations, this is reflected in the weak correlation between the functional response to bronchodilator inhalation assessed by forced expiration and the undisputable clinical benefit for the patient. Part of this complex relationship is based in the multiple mechanical alterations that occur in severe COPD and can be elucidated by the assessment of, e.g., forced inspiration[1] and dynamic hyperinflation.[2]

In patients with severe COPD who are at rest, the reduction of dyspnoea after bronchodilator inhalation has been demonstrated to be primarily related to the improvement of forced inspiration, such as changes in the forced inspiratory volume in 1 s (FIV_1).[1,3] Although forced inspiration is not undemanding with regard to the patient's cooperation, its assessment might be more feasible in outpatient settings and clinical routine than, for example, the determination of dynamic hyperinflation. Moreover, in view of the demonstrated relationship between changes in dyspnoea and FIV_1 or peak inspiratory flow (PIF),[1,3] the assessment of forced inspiration by the patient at home could be a particularly attractive option to obtain a functional correlate of dyspnoea.

Measurements at home require a portable, robust, affordable device, similar to conventional peak flow meters. Such instruments are not in common use, there are, however, devices designed for the assessment of inspiratory flow rates in order to aid in the choice of the inhaler most suitable for the patient. Although these instruments, owing to their specific purpose and construction, might yield readings that differ from those of high-end spirometers, they could still be useful for clinical monitoring. Recently, a detailed analysis became available comparing one of these devices with conventional lung function measures.[4] We used the same device in patients with COPD to determine whether its readings were related to the change in dyspnoea after bronchodilator inhalation, and whether these measurements were reproducible.

Patients and methods

Patients

Thirty-seven patients with COPD (GOLD II/III/IV $n = 16/15/6$)[5] participated in this study (online repository Table 1). All patients were in a stable state of their disease. Medication was held constant throughout the study, with the exception of short-acting and long-acting bronchodilators which were withdrawn 8 and 24 h, respectively, before measurements. Thirty-two patients were treated with long-acting β_2-adrenoceptor agonists, 26 patients with long-acting anticholinergics, 7 patients with theophylline, and 19 patients with inhaled corticosteroids. No patient was on oral corticosteroids. Fifteen patients were smokers, all others ex-smokers. The protocol was approved by the local Ethics Committee and patients gave their written informed consent.

Study protocol

The study was performed on three separate days. On day 1 a clinical history was taken and lung function measurements were performed to obtain the patients' baseline characteristics. The other two study days had the same sequence of assessments to determine reproducibility. They were separated by at least 2 and maximally 14 days. After an interval of 30 min which the patients spent at rest, lung function measurements were performed to obtain baseline values. Patients then inhaled 24 μg of formoterol (2 puffs of Oxis® by Turbuhaler®; AstraZeneca, Wedel, Germany); 30 min later lung function was re-assessed. The two values before and after formoterol inhalation were used to determine bronchodilator responses. Moreover, patients rated their changes in dyspnoea after the 30 min period on a visual analogue scale (VAS). It was ensured that the patients understood the scale and the three possibilities of improvement, no change, and worsening of breathlessness. Each subject was instructed to mark the VAS line at any point at which he or she wished to do so. Ratings were expressed as percents of the full VAS line length, the range being from −100% (very much worse) to +100% (very much better). Patients were carefully advised to rate only shortness of breath, and to ignore other sensations such as cough or chest tightness.[1,6,7]

Assessments in the laboratory

Lung function tests consisted of body plethysmography and spirometry including forced exspiration and forced inspiration, in that order. Measurements were performed according to the recommendations and quality standards of the ATS/ERS[8–10] or previously used standards.[1] These measurements were followed by the assessment of maximum inspiratory flow rate using an inspiratory peak flow meter (InCheck, Clement Clarke International Ltd, Harlow, UK). For this manoeuvre patients slowly exhaled until RV and then inhaled with maximal effort. The device was used without additional resistance. At least 3 attempts were made and the best of these was taken for analysis. Patients were explicitly encouraged to perform maximal manoeuvres, and values that were obviously incorrect were discarded. The values recorded by this device are subsequently denoted as IF-IC values.

Data analysis

Mean values and standard deviations (SD) were taken for data description. Baseline characteristics were compared between the two days by the paired *t*-test. Bronchodilator responses were expressed as absolute and relative changes occurring after inhalation. These responses were also compared between study days by the paired *t*-test. Additionally, analysis of variance (ANOVA) was performed, with measuring time and day as factors, whereby differences between responses at the 2 days would have resulted in significant measurement−day interaction. In this ANOVA design the factor indicating whether measurements were performed before or after formoterol inhalation was nested within the day factor. The validity of ANOVA assumptions was checked by analysis of residuals.