

FreeO₂: closed-loop automatic titration of oxygen flow based on SpO₂. Evaluation in COPD patients during endurance shuttle walking.

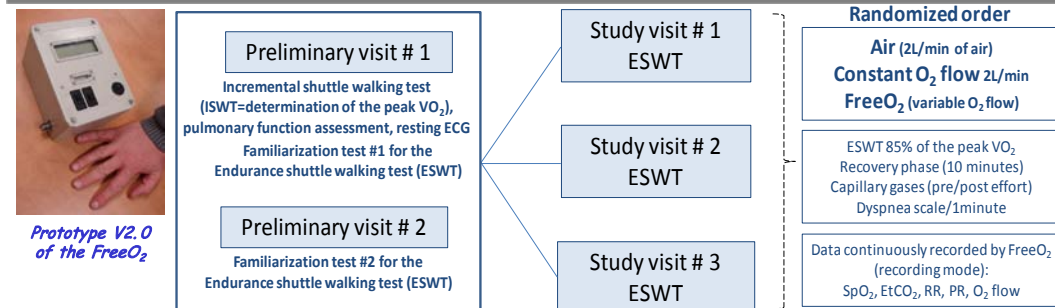
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Introduction

More than one million of COPD patients receive long term oxygen therapy (LTOT) at home in United States¹. In spite of oxygen therapy, desaturations frequently occur during exercise², during the night³ and even at rest⁴. During exertion, oxygen therapy is associated with short term physiological benefits⁵⁻⁷. Current recommendations are to add 1L/min to the baseline oxygen flow during exertion⁸. However, clinical benefits with current administration of oxygen during exercise are not clear⁹. We developed a new closed-loop system (FreeO₂) that automatically adjusts every second the oxygen flow to the patient's needs based on the SpO₂, EtCO₂ and respiratory rate. The aim of this study is to evaluate this system in COPD patients during endurance shuttle walking.

Methods (Figure 1)



Inclusion criteria: age > 40 years, moderate to very severe COPD with known desaturation during exertion (or suspected if SpO₂ at rest is below 95%), smoker or ex-smoker. Five visits are planned with a minimum of 48 hours between each visit (Figure 1). At study visits # 1, 2 and 3, one ESWT is performed in a random order with one of the following conditions:

- 1) air (at 2L/min)
- 2) oxygen (at 2L/min)
- 3) FreeO₂ (variable oxygen flow: SpO₂ target set at 94%).

The patients were blinded for the condition tested as well as investigators, except for one.

Results

10 patients have been included and 9 have completed the study. Patient #7 did the first study visit, but deterioration of his clinical condition did not allow to complete the whole study. Mean age was 69±8 years, mean FEV₁ 1.2±0.4L (50±13% pred.), baseline PaCO₂ was 41±4mmHg (3 patients had PaCO₂ > 45 mmHg), baseline PaO₂ was 74±12mmHg. None of the patients had received LTOT.

Four patients attained the maximum duration of the ESWT test with FreeO₂ and one with constant O₂.

With FreeO₂, mean and maximum oxygen flows were 3.5±1.9 and 6.7±2.3 L/min respectively.

References: 1-O'Donohue Chest 1995; 2-Pepin AJRCCM 2005; 3-Plywasczewski Chest 2000; 4-Soguel Schenkel ERJ 1996; 5- O'Donnel AJRCCM 1997; 6-Emtner AJRCCM 2003; 7-Bradley Cochrane 2005; 8-Celli ERJ 2004; 9-Lacasse ERJ 2005; 10- Pepin Thorax 2011

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Results

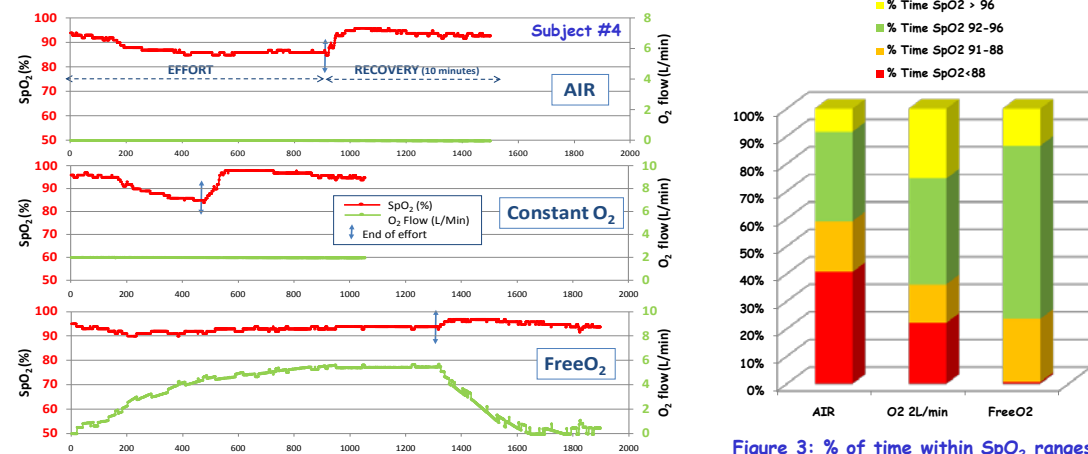


Figure 2: ESWT followed by recovery in the 3 tested conditions

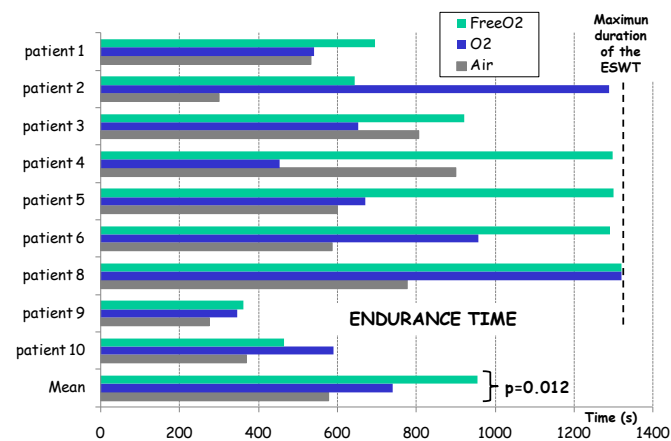


Figure 4: Impact of the tested condition on the endurance time

Figure 3: % of time within SpO₂ ranges

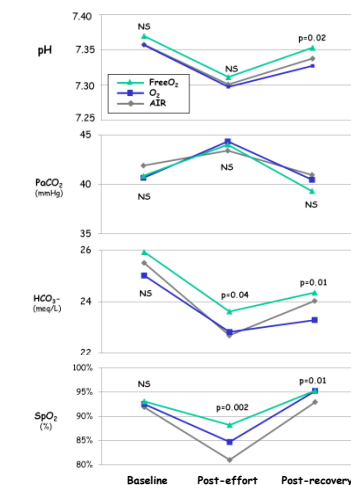


Figure 5: Impact on arterial blood gases

Conclusions

In these preliminary data, automatic adjustment of oxygen during exertion was associated with increased endurance time and walking distance. The gain in walking distance was above 200 meters and almost 400 meters when compared with oxygen and with air. It was recently stated that a change in endurance shuttle walking performances above 60 meters was likely to be perceived by patients (after bronchodilatation)¹⁰. SpO₂ was better maintained within the predefined ranges and severe desaturation were less than 1% with FreeO₂. In spite of high oxygen flows during exertion with FreeO₂ (up to 11.3 L/min), no induced-hypercapnia occurred probably because hyperoxia was avoided. This system may improve exercise tolerance and maintain oxygenation during daily activity such as walking in patients with COPD.

