Comparison of hyperpolarized 3-He administration methods in healthy and diseased subjects

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Purpose

To determine the physiological effects and responses to hypoxic and anoxic breath holds administered by two different methods during the course of a hyperpolarized 3-He imaging session.

Materials and methods

Two groups of patients (Healthy Non-smokers & Emphysema) were imaged with the same protocol:

1. Flip angle calibration breath-hold (5 sec)
2. Static ventilation breath hold (18 Sec)
3. Free breathing dynamic sequence (1-3 sec)
4. ADC breath hold (15 sec)

Two separate cohorts from the same patient groups were imaged using two separate methods of gas administration; the first a simple bag and tube containing a mixture of 300mL 3-He and 700mL N_2, the second a computer controlled applicator device driven by a ventilator [1] capable of delivering a measured amount of gas followed by an air "chaser". Oxygen saturation (SpO_2) was measured for the first minute following each breath hold maneuver using an MRI compatible monitoring device (Maglife. *Bruker, Wissembourg, France*)

	Bag	Applicator
Healthy Non-smokers	8 (48)	4 (59)
Emphysema	7 (52)	16 (63)

Table 1. Distribution of subjects; Mean age in brackets

Results

The baseline SpO_2 was marginally higher in both subject groups when the applicator was used. Both groups experienced a slight drop in SpO_2 when the bag was used to administer the gas, the group of healthy non-smokers showing the largest mean drop of 4%. While the group with emphysema showed only a 1% drop in SpO_2. When the applicator device was used, the mean SpO_2 of both groups remained within 1% of the baseline value (figure 1). None of the participants reported any ill effects for either method.

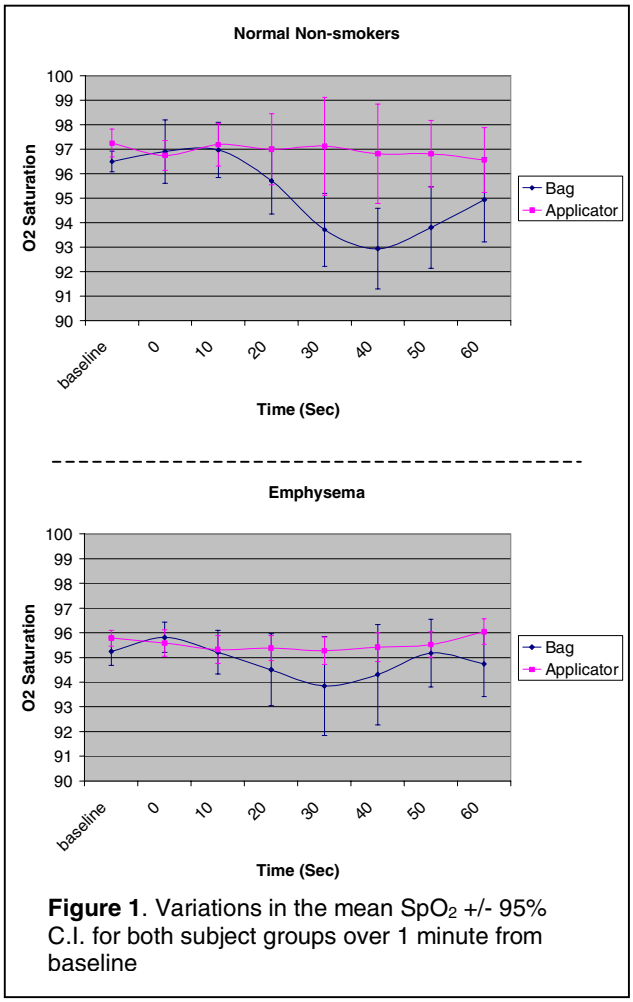

Figure 1. Variations in the mean SpO_2 +/- 95% C.I. for both subject groups over 1 minute from baseline

Discussion

Both patient groups experienced a small drop in SpO_2 when using the bag to administer the mixture of hyperpolarized 3-He and N_2, although the mean drop in saturation was much lower in the emphysematous group. One potential explanation is that healthy subjects are able to take a much deeper breath in, resulting in greater displacement of alveolar gasses by the anoxic mixture. Secondly, emphysematous patients have inherent averaging of blood gas values as some areas remain hypo-ventilated due to airway obstruction and continue to contribute to blood oxygenation as alveolar air is not replaced by the anoxic gas. The applicator operates using Continuous Positive Airway Pressure (CPAP) which keeps the alveoli dilated. The bolus of hyperpolarized 3-He from the applicator is followed by an air "chaser" so the breathing maneuver is hypoxic rather than anoxic, this could explain the low mean variability in SpO_2 when using the applicator method. The bag method is the simplest to use requiring minimal setup and safety of application has previously been reported [2], whereas the applicator involves the use of a CPAP mask which must remain in-situ throughout the examination. However, we believe that this is the first time the safety aspects of such a device have been reported. Perhaps the most important fact is that this data represents 136 doses of 3-He with minimal changes to SpO_2 and no reported adverse events.

References

1. Eberle B et al., *Analysis of intrapulmonary O2 concentration by MR imaging of inhaled hyperpolarized helium-3.* J Appl Physiol, 1999. 87(6): p. 2043-2052.
2. De Lange E et al., *Hyperpolarized gas MR imaging of the lung: safety assessment of inhaled helium-3.*Proc. RSNA 2003 abstract K03-879