The Effect of Posture on Ventilation using SLP in Healthy Subject and Patients with Alpha-1 Antitrypsin Deficiency (AATD).

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Introduction

Patients with the PiZ phenotype of AATD have severely reduced plasma levels of Alpha-1 Antitrypsin. They tend to develop predominantly basal emphysema as opposed to the central emphysema typically seen in usual COPD. However, some subjects have exhibited a greater involvement of the apex of the lungs [1].

SLP is based on the analysis of breathing by the projection of a light grid onto the chest and abdomen (Figure 1). By using two digital cameras to track 3D movement, the computer can accurately measure the movement of the whole thoracic-abdominal wall, as well as isolated regions within this area [2].

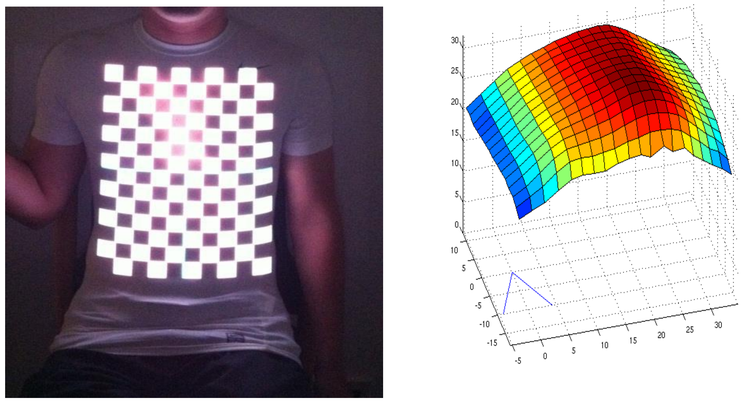

Figure 1: The projected light grid from SLP with subject's anterior chest and abdominal wall (Left). Computerised 3D reconstruction of the light grid. Red depicts the greatest movement while blue depicts the least (Right).

The system measures a number of parameters;

1. IE50: The ratio of inspiratory 'flow' at 50% of tidal volume (Vt) to expiratory 'flow' at 50% of Vt. A longer expiratory time can be indicative of airflow obstruction.

2. Relative Thoracic Contribution (RTC): The ratio of a region's movement change compared to the Vt (taken to be the total chest wall movement) (Figure 2).

3. Phase Angle (PA): Measure of synchronicity between two regions (e.g. Thorax and Abdomen or Upper and Lower Thorax). A phase of 0^o or 360^o indicates both regions are in perfect synchrony. A phase of 180^o means one region moves in paradox to the other (Figure 3).

This is a novel, innovative tool for assessing respiratory physiology, which is non-invasive, accurate and easy to use. Furthermore, it is not affected by humidity and temperature variations like traditional plethysmography technologies and it can be used to perform measurements for extended periods of time.

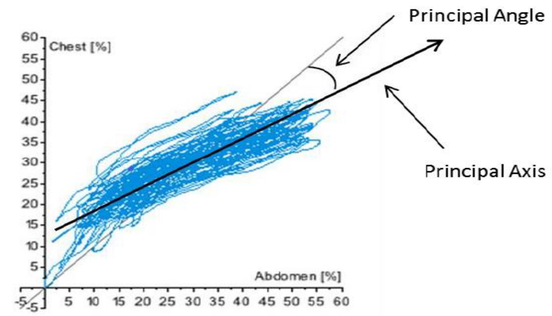

Figure 2: RTC is the angle of the Principal Axis of the Kono Mead plot relative to a 45 degree line. Here, the principle angle is negative, indicating a higher degree of abdominal involvement. A positive angle would indicate thoracically-dominant breathing.

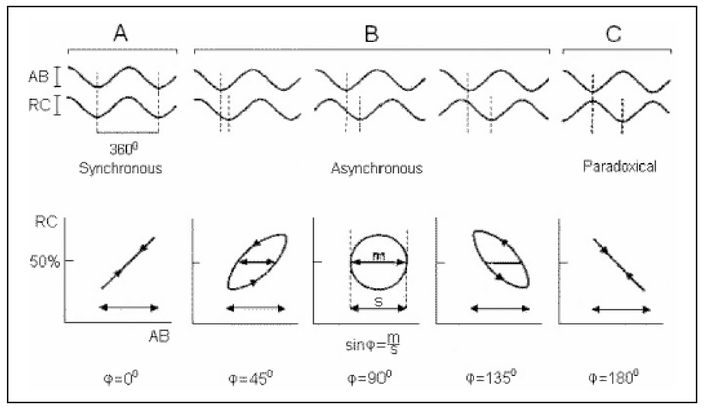

Figure 3: Illustrations showing the different phase angles in relation to the synchronicity of breathing. Asynchronous thoracic/abdominal movement is often observed in airflow obstruction, particularly when patients are in a supine position (Aliverti, 2000).

Methods

SLP was measured using the Thor3Di (PneumaCare, Cambridge, UK) for 50 consecutive tidal breaths in both a seated and supine position in healthy control subjects (n=16) and patients with PiZ AATD (n=27).

- Healthy control data was used to validate measurements against current understanding of respiratory physiology.

- Healthy control data was then compared to data from patients with AATD to determine if noticeable differences in physiology can be detected.

Results

No differences in RTC or PA were observed between AATD patients & healthy control (HC) subjects. (Figure 4).

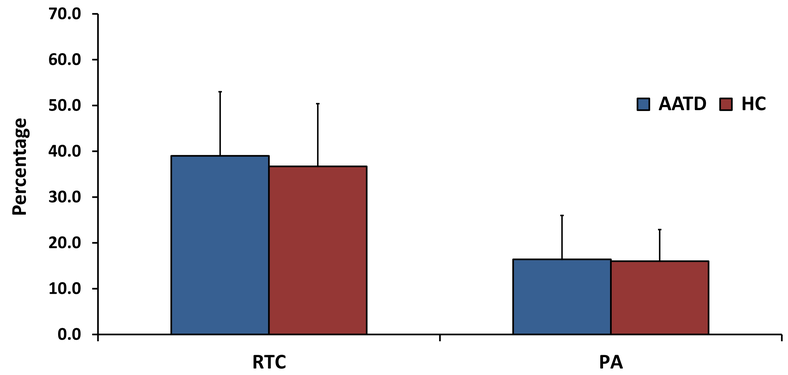

Figure 4: A comparison of respiratory patterns measured by SLP patterns in AATD patients and Healthy Control (HC) when supine.

However, significant differences in both RTC and PA were observed between the seated and supine positions in both healthy controls and patients with AATD;

Group	Parameter	Seated (Mean + SD)	Supine (Mean + SD)	p-value
AATD	RTC (%)	49 (10.6)	39 (14.5)	<0.01
AATD	PA (^{o})	7.1 (3.4)	17.5 (13.5)	0.001
HC	RTC (%)	54 (12.6)	36 (9.2)	<0.001
HC	PA (^{o})	6.2 (2.9)	16.6 (7.8)	<0.01

Conclusions

SLP is an accurate, useful and non-volitional tool for assessing thoracic and abdominal contribution to tidal ventilation.

Differences in RTC and PA between seated and supine suggest both healthy subjects and patients with AATD become more asynchronous from seated to supine.

References

1. Parr D, et al. Pattern of Emphysema distribution in A1-Antitrypsin deficiency influences lung function impairment. *AJRCCM* 2004; 170: 1172–1178.

2. Usher-Smith JA, et al. Structured Light Plethysmography in infants and children: A pilot study. *Arch Dis Child* 2009; 94(Suppl I): A38.