Influence of torso position on chest examinations by electrical impedance tomography

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Abstract: During pulmonary function testing (PFT), patients tend to tilt from upright to leaning forward position. The influence of torso movement on EIT chest examinations is unknown. We studied this effect in healthy subjects and patients with pulmonary diseases and found significant position-dependent changes in end-expiratory impedance that may impact EIT findings during PFT.

1 Introduction

EIT examinations during PFT allow the assessment of regional lung function in spontaneously breathing subjects [1]. Forced full expiration manoeuvres are typically carried out during conventional PFT in adult patients that enable for instance the evaluation of the degree of airway obstruction. During this manoeuvre, the sitting patients tend to lean forward by bending from the waist. The aim of our study was to determine if this torso movement affects the chest EIT examinations.

2 Methods

We examined 21 adult subjects; one subject was excluded from analysis because of continuing electrode contact failure. Five healthy subjects (37±4 years, mean age ± SD) had no history of lung disease and 15 patients (72±78 years) suffered from obstructive lung diseases. All subjects were examined during quiet tidal breathing: first, in the upright sitting position, followed by the leaned forward position by about 40° with subsequent return to the upright position (Fig. 1). In each position, three to six tidal breaths were recorded. The EIT data were acquired using the Goe-MF II EIT device (CareFusion, Höchberg, Germany) at 33 images/s. Raw EIT images were reconstructed using the GREIT algorithm [2]. The baseline data originated from the initial measurement phase in the upright position. We then identified the end-expiratory (i.e. minimum) values and the tidal signal amplitudes representing the end-expiratory and tidal volumes of each breath, respectively, in all three measurement periods. Afterwards, the mean end-expiratory values were calculated from each of the three phases and the differences among the studied torso positions determined. To ensure better inter-individual comparability, the individual end-expiratory differences among the three phases were normalised by the initial average tidal EIT signal variation in the first measurement phase of each subject. Friedman test and one-way ANOVA were used to determine the statistical significance of the torso position effect on end-expiratory impedance values in healthy subjects and patients, respectively. P values <0.05 were considered significant.

3 Results

The torso position exhibited a significant effect on end-expiratory impedance values both in healthy subjects (P=0.024) and patients (P=0.003). With the torso leaned forward, end-expiratory impedance increased in all healthy subjects and in 13 out of 15 patients. This impedance shift equalled in average 1.04 (95% confidence interval (CI):0.69-1.39) and 0.67 (95% CI:-0.14-1.20) of the mean tidal impedance amplitude in each group, respectively. The end-expiratory impedance returned to its initial level after the upright posture had been resumed. The differences between the two upright phases were insignificant. They equalled in average 0.08 (95% CI:-0.19-0.35) and 0.03 (95% CI:-0.18-0.24) of the mean tidal impedance amplitude.

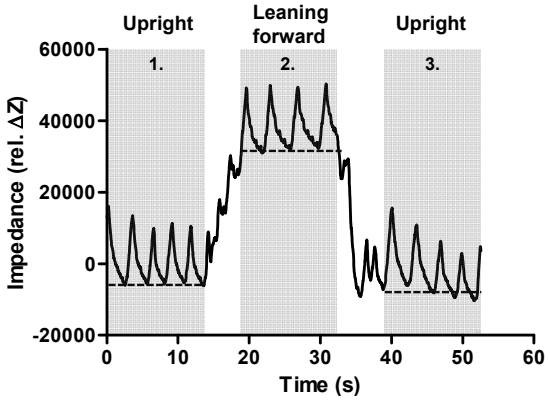

Figure 1: Global EIT waveform acquired during an examination of a spontaneously breathing 73-yr old male patient with chronic obstructive lung disease in upright (1.), forward leaning (2.) and upright positions (3.). The analysed measurement phases are highlighted; the dashed lines show the mean end-expiratory impedance values within each phase.

4 Conclusions

The forward movement of the torso exerts a significant effect on the EIT waveforms registered during otherwise undisturbed tidal breathing. The observed changes in end-expiratory impedance may impact the findings during PFT. We recommend strict adherence to the upright sitting position during PFT when EIT is used.

5 Acknowledgements

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6 References

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