Electrical impedance tomography: Robustness of a new pixel wise regional expiratory time constant calculation

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Electrical impedance tomography: Robustness of a new pixel wise regional expiratory time constant calculation

A.D.Waldmann[1], S.H.Bohm[1], W.Windisch[2], S. Strassmann[2], C. Karagiannidis[2]
[1]Swisstom AG, Switzerland, [2]Kliniken der Stadt Köln, Pneumology and Critical Care Medicine, Ostmerheimer Str. 200, 51109 Cologne, Witten/ Herdecke University Germany

INTRODUCTION

Passive exhalation shows a characteristic exponential course with asymptotic approximation of the end expiratory lung volume. It can be described as $V(t)=V_{insp}\cdot e$^(-t/(R·C)) where V is the lung volume at time *t*, V_{insp} the volume at end inspiration, R the resistance and C the compliance of the lungs. The product of R times C is called τ (tau). Although R and C can vary considerably between different lung regions, traditional pulmonary function tests provide global values, only. Therefore, we recently proposed [1] a novel method to obtain continuously breath-by-breath regional τ values using electrical impedance tomography (EIT). As this approach can be challenging in the presence of small ventilation amplitudes, noisy signals and heterogeneity we determined in this study its robustness.

METHODS

In 8 intubated patients, with hypoxemic or hypercapnic respiratory failure, we measured EIT signals at 50 images per second using *Swisstom BB*[2] recording 30 consecutive breaths during steady state conditions. Regional breath by breath τ values (see Fig 1) were estimated by fitting an exponential model to each regional curve. Only τ values within the range of 0.05 and 3 s stemming from appropriately fitted curves ($R^2>0.6$) were considered thereby excluding poorly ventilated and poorly fitted lung areas. To estimate the robustness of τ, we calculated the regional coefficient of variation (CV) for all breaths as the standard deviation divided by the mean.

RESULTS

Mean and median CV values of each patient were below 5%, however some pixels showed values of up to 25% mainly at the lung boundaries or close to poorly ventilated areas.

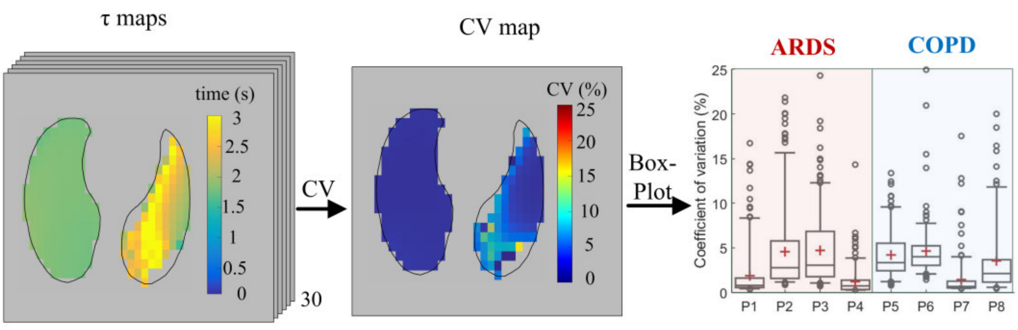

Fig1: Left: τ maps from 30 breaths were used to calculate the regional CV map for each patient (centre), right: box-plot (whiskers represent all points between 5% and 95% within each distribution) from the CV maps of 8 patients, mean values are highlighted by a red crosses.

DISCUSSION

The suggested approach for calculating regional expiratory τ values provided robust results with low coefficients of variation. However, certain lung regions at the lungs´ boundary showed high variability. Therefore, to increase reliability such pixels should be excluded from future calculations.

REFERENCES

[1] Roka et al., “Expiratory time constants by electrical impedance tomography inhypoxemic and hypercapnic acute lung failure – a feasibility study” Intensive Care Medicine Experimental 2015, Volume 3 Suppl 1

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eit inside ® electrical impedance tomography