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Assessment of regional lung filling characteristics by Electrical Impedance Tomography and dynamic Computed Tomography

F Thuerk, A Waldmann, N Verdier, A Wielandner, C Braun, E Kaniusas; European Society of Anaesthesiology (ESA), London, UK, May 28-30, 2016

Real-time tomographic images for organ function monitoring and diagnosis

eit inside ® electrical impedance tomography

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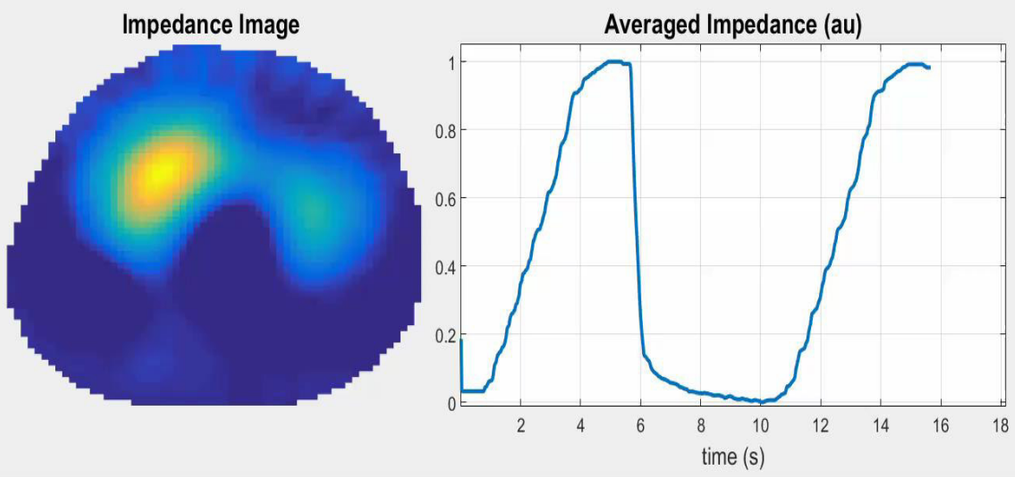
INTRODUCTION

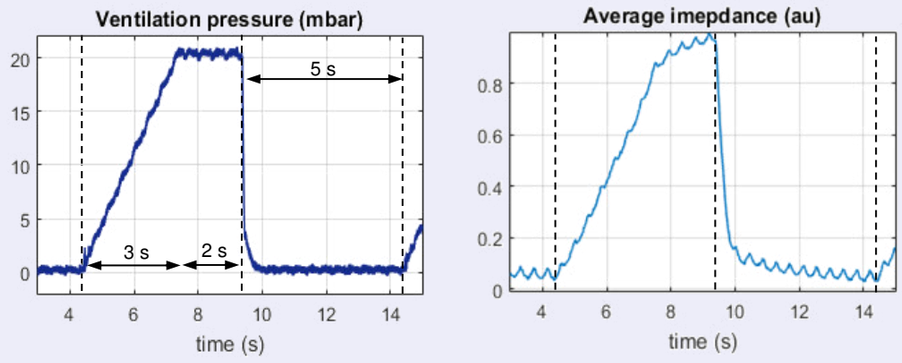
- Monitoring **lung function** during mechanical ventilation at the bedside is of increasing clinical interest.
- Electrical impedance tomography (EIT) has previously shown its ability to **non-invasively** detect changes in **ventilation distribution** [1].
- This study compared **regional time delays** derived from EIT and dynamic computed tomography (dCT) as reference.



METHOD

Protocol

- Three **mechanically ventilated** (elisa 800, SALVIA Medical, Germany) pigs (25 - 35 kg) with
  - inspiratory **pressure ramp** of 3 s
  - $P_{endinsp}$ to gain a tidal volume of 10 ml/kg BW
  - PEEP levels of 0, 5, 10 and 15 mbar.
- Measurements in **healthy** (H) and **lavaged** (LAV) lungs



Imaging

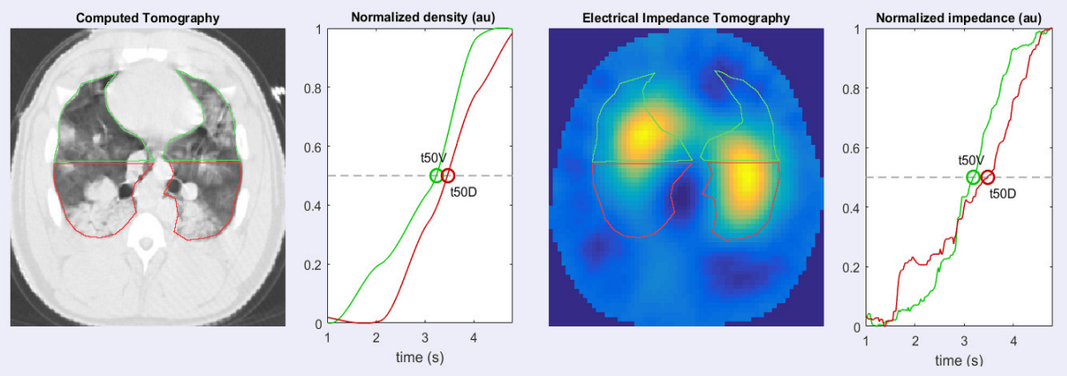
- **EIT** (PioneerSet, Swisstom, Switzerland)
- **dCT** (Emotion 16, Siemens AG, Germany)

Processing

- Images were reconstructed using GREIT [2].
- Lung regions in EIT were defined by CT contours
- The times until **50% of the inspiratory peaks** (t50) were reached in EIT and dCT for
  - **non-dependent** (t50V) and
  - **dependent** (t50D) lung regions and the
- **time differences** (Δt50) between non-dependent and dependent lung regions were assessed.

RESULTS

- In both EIT and dCT, t50D was **higher** than t50V
- In EIT, mean difference of t50D and t50V was significantly lower (compare Table 1) in H compared to LAV throughout all PEEP levels (0.06 s and 0.19 s; $p<0.01$).
- These results were also observed in regional dCT analysis (mean Δt50D of 0.04 s and 0.1 s).



	Healthy, Δt50 (s)		Lavage, Δt50 (s)	
PEEP (mbar)	EIT	dCT	EIT	dCT
0	0.03 ± 0.05	0.09 ± 0.15	0.16 ± 0.06 *	-0.09 ± 0.34
5	0.09 ± 0.07	0.03 ± 0.22	0.23 ± 0.18 *	0.2 ± 0.56
10	0 ± 0.04	-0.06 ± 0.24	0.18 ± 0.06 *	0.09 ± 0.23
15	-0.09 ± 0.96	0.17 ± 0.55	0.19 ± 0.17 *	0.28 ± 0.4

Table 1. Differences between dependent (dorsal) and non-dependent (ventral) t50 times in seconds. Values are mean ± standard deviation of three pigs. Asterisks mark significant differences in EIT between healthy and lavage ($p<0.05$).

DISCUSSION

Since EIT measures **relative impedance changes**, the described method is limited to the lung areas affected by tidal ventilation. Thus, functionally mute behaving pixels – representing e.g. fixed atelectasis – have no impact on the presented analysis. Further, the analyses were based on CT thoracic boundaries and lung contours. Nevertheless, the assessed time-constants reflect the functional lung behavior during tidal ventilation.

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