Appendix 1: Automatic electrical impedance tomography (EIT) algorithm for regional lung mechanics

Determination of aerated lung area

First, the total aerated lung area was defined to determine the range of EIT pixels (i.e., lung zones) in which the peak flow analysis can be applied. For all separate positive end-expiratory pressure (PEEP) levels, the maximum regional relative impedance of all pixels is determined:

$$\Delta Z_{max,n} = max\left(\Delta Z_{j,n}\right) \quad [1]$$

Where $\Delta Z_{j,n}$ represents the regional tidal impedance difference of pixel j at the n^{th} PEEP step during the decremental PEEP trial. A specific pixel is considered to be ventilated at the n^{th} PEEP step when its $\Delta Z_{j,n}$ is equal to or larger than 7.5% of $\Delta z_{max,n}$ at least once in time:

$$\begin{aligned} \Delta Z_{j,n}(t) \leq 0.075 \cdot \Delta Z_{max,n} \rightarrow SURF_{j,n} = 1 \\ \Delta Z_{j,n}(t) \leq 0.075 \cdot \Delta Z_{max,n} \rightarrow SURF_{j,n} = 0 \end{aligned} \quad [2]$$

Where *i* represents the pixel number, *n* the n^{th} PEEP step, *t* is an arbitrary time point during the measurement at the specific PEEP step and surface (*SURF*) summarizes the total aerated area (1: a pixel is ventilated; 0: a pixel is not ventilated) in pixel *j* and PEEP step *n*. This process is repeated for all separate PEEP steps. Last, the aerated area figures of all PEEP steps are stacked, creating the total aerated area (i.e., matrix *k*) during the complete EIT measurement. This matrix *k* is used for further analyses.

Global and regional landmark detection

For an optimal representation of the regional mechanical properties, each breath within an aerated pixel at the n^{th} PEEP step is included in the RPF analysis. Therefore, extraction of all these breaths is required. The start of the aerated pixel inspiration and expiration is defined as the troughs and peaks during a respiratory cycle, respectively and can be determined mathematically by equaling the first derivative of $\Delta Z_{j,n}$ to zero:

$$Landmarks_{j,n} = \Delta Z_{j,n}'(t) = 0 \quad [3]$$

where $\Delta Z_{j,n}$ is equal to the regional tidal impedance difference of aerated pixel number *j* in matrix *k* at the n^{th} PEEP level. $Landmarks_{j,n}$ describes all starts of inspiration and expiration for each aerated pixel j at the n^{th} PEEP level.

ODRPF and CLRPF

After all separate breaths of each aerated pixel in matrix *k* at the n^{th} PEEP step are extracted, the regional airflow trend during inspiration for each breath at the n^{th} PEEP step can be determined by a 3-sample first derivative:

$$Q_{j,n}(t_m) = \frac{\Delta Z}{\Delta t} = \frac{\Delta Z_{j,n}(t_{m+1}) - \Delta Z_{j,n}(t_{m-1})}{t_{m+1} - t_{m-1}} \quad [4]$$

Where $Q_{j,n}(t_m)$ represent the regional inspiratory flow at time point t_m in pixel *j* at the n^{th} PEEP level and $\Delta Z_{j,n}(t_m)$ the regional tidal impedance difference at time point tm. During inspiration, the highest regional airflow within $Q_{j,n}(t_m)$ is considered to be the regional peak flow (RPF) for that specific breath in pixel *j* at the n^{th} PEEP level (i.e., $RPF_{j,n}$). This calculation is subsequently repeated and averaged per PEEP level for all included breaths in all pixels within matrix *k*.

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Subsequently, regional overdistension and collapse rates per PEEP step based on RPF are calculated as follows:

$$
\begin{aligned}
OD_{j,n}(\%) &= \frac{RPF_{j,high} - RPF_{j,n}}{RPF_{j,high}} \cdot 100 \rightarrow for\ PEEP_n > PEEP_{RPF,high} \\
CL_{j,n}(\%) &= \frac{RPF_{j,high} - RPF_{j,n}}{RPF_{j,high}} \cdot 100 \rightarrow for\ PEEP_n < PEEP_{RPF,high}
\end{aligned} \quad [5]
$$

Where $CL_{j,n}$ and $OD_{j,n}$ represent the RPF based regional collapse and overdistension rate at the n^{th} PEEP step in pixel j, respectively. $RPF_{j,high}$ represents the highest value of all RPF_j measured during the PEEP trial in pixel j, while $RPF_{j,n}$ symbolizes the RPF at the n^{th} PEEP step in pixel j. A pixel is considered to be overdistended when there is a loss of RPF as a result of a PEEP step higher than the optimal PEEP for that specific pixel j and vice versa for collapse.

Interpolation

The regional overdistension-collapse matrix at the n^{th} are then interpolated by a factor four using a cubic approach which results in a regional overdistension and collapse matrix with a spatial resolution of 497×497 pixels.

Cumulative overdistension and collapse

Following the calculation of the RPF-based regional overdistension and collapse rates per PEEP step, a cumulative overdistension and collapse rate for matrix k at the n^{th} PEEP step can be calculated:

$$
\begin{aligned}
OD_{RPF,n}(\%) &= \frac{\sum_{j=1}^{k}\left(OD_{j,n} \cdot RPF_{j,high}\right)}{\sum_{j=1}^{k} RPF_{j,high}} \\
CL_{RPF,n}(\%) &= \frac{\sum_{j=1}^{k}\left(CL_{j,n} \cdot RPF_{j,high}\right)}{\sum_{j=1}^{k} RPF_{j,high}}
\end{aligned} \quad [6]
$$

Where $OD_{RPF,n}$ and $CL_{RPF,n}$ represents the cumulative overdistension and cumulative collapse rate at the n^{th} PEEP step in matrix k.

Table S1 Comparison of patient characteristics at admission between included and excluded patients within the study time

Patient characteristics	Included (n=78), mean (± SD) or frequencies (%)	Excluded (n=16), mean (± SD) or frequencies (%)	P value
Age, years	63.9 (±10.5)	65.5 (±13.0)	0.741†
Male, N	61 (78.2%)	12 (75.0%)	0.839‡
Body mass index, kg/m^2	27.8 (±4.3)	26.7 (±2.9)	0.431†
Chronic lung disease, N	4 (5.1%)	4 (25.0%)	0.001‡*
APACHE II score, points	16.3 (±3.7)	15.1 (±8.4)	0.200†

*, P value <0.05; †, Mann-Whitney U-test; ‡, Chi-square test. APACHE, Acute Physiology and Chronic Health Evaluation; N, number of observations; SD, standard deviation.

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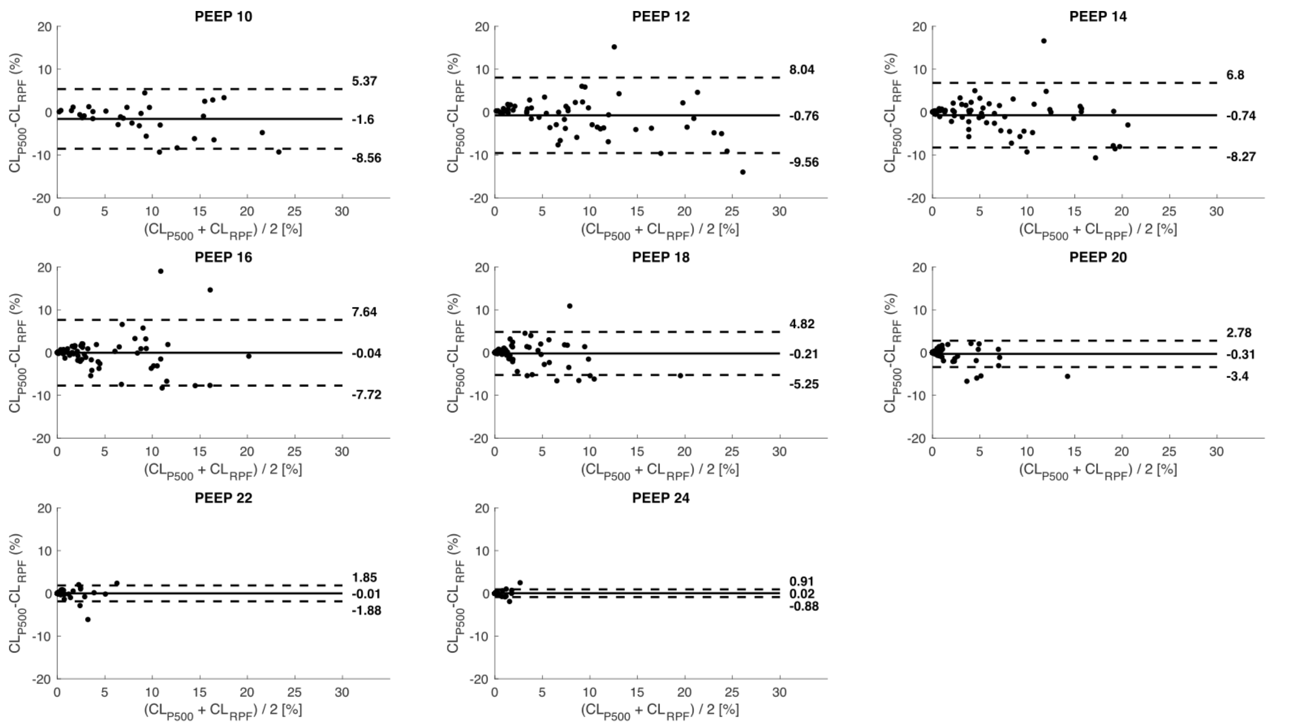

Figure S1 Bland Altman plots for CLP500 and CLRPF in all PEEP levels. CLP500: cumulative collapse rate by the Pulmovista 500, CLRPF: cumulative collapse rate by the regional peak flow algorithm, PEEP: positive end-expiratory pressure.

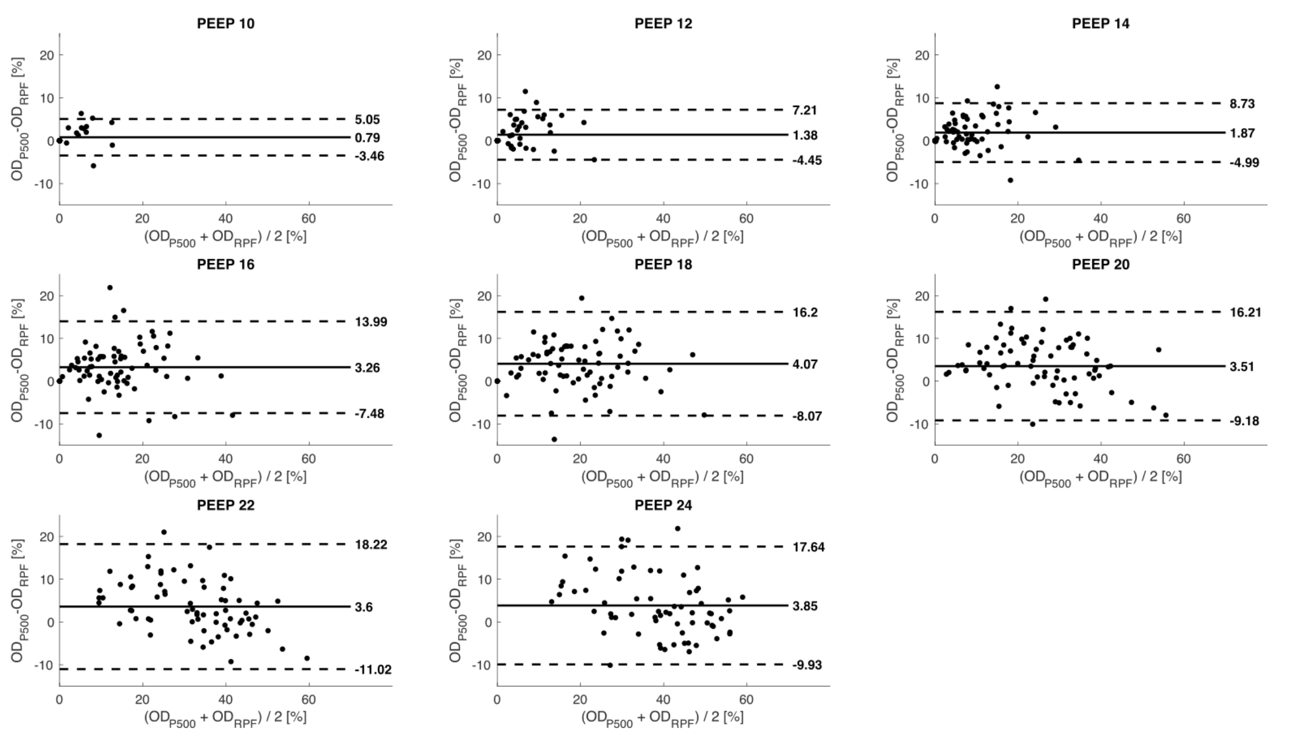

Figure S2 Bland Altman plots for ODP500 and ODRPF in all PEEP levels. ODP500: cumulative overdistension rate by the Pulmovista 500, ODRPF: cumulative overdistension rate by the regional peak flow algorithm, PEEP: positive end-expiratory pressure.

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