In clinical routine, computed tomography (CT) is considered as the gold standard for evaluation of lung recruitment and lung aeration inhomogeneity. Nevertheless, CT has disadvantages that should be taken into account, including a high dose of ionizing radiation, inaccessibility of CT bedside and impossibility of its continuous usage. Electrical impedance tomography (EIT) does not have these disadvantages; therefore, EIT might be a suitable alternative to CT for the lung monitoring. The term “tomography” in “EIT” evokes that it is primarily an imaging technique; however, due to the physical principle, EIT can never reach as high spatial resolution and tissue contrast as CT. Therefore, EIT data should be processed in an index-like manner rather than evaluated as an image. Due to the complex analysis, the data processing is sensitive to errors and misinterpretation. The aim of the study is to show how EIT can be used for lung recruitment evaluation and to show possible sources of errors during the EIT data processing.

The whole EIT measurement process consists basically of three major parts: data acquisition, data processing and data presentation with their consequent interpretation.

The major source of errors during data acquisition is an improper placement of EIT electrodes, often integrated into an electrode belt. This involves a shift of the electrode belt in the cranio-caudal direction, a radial rotation of the belt and an insufficient contact of one or more electrodes. When a long-time EIT recording is required, continuous operation of the equipment without recalibration (that is frequently requested e.g. by PulmoVista 500 EIT system) is essential.

The initial step in EIT data processing is a selection of common reference frame, referred to as the baseline frame. According to the concept of functional EIT (fEIT), the selection of baseline frame affects reconstructed values in the whole data set. Especially when processing a long-time EIT records, it is essential that all the individual data segments are processed with the same baseline frame.

Once the data are successfully reconstructed, filtration in time domain is capable to suppress the artifacts caused by heart activity. For evaluation of lung ventilation distribution, the regions of interest (ROIs) are defined within the EIT images. There are basically two different concepts of ROI definition. The first one is based on determining the area in the image that corresponds to the presence of lung tissue in the cross-section of the body. In this case, the ROI is determined by pixels with sufficient
impedance changes during a breath cycle. The second approach is based on splitting the whole EIT image to equally-sized regions, usually horizontal layers, in which regional percentages of the total lung ventilation are calculated.

In time domain, lung recruitment can be evaluated using impedance waveforms obtained from the EIT images. In this approach the end-expiratory lung impedance (EELI) values corresponding to end-expiratory lung volumes (EELV) are determined as local minima of impedance waveforms. For example, efficacy of a recruitment maneuver and the consequent stability of the lungs can be evaluated using EELI data recorded before and after the maneuver. Other regional lung characteristics, such as regional compliance or regional time constants, and additional global characteristics, such as center of ventilation or a center of gravity, can be calculated as well.

The interpretation of EIT data may be ambiguous. For example when ROIs are defined by impedance change during a breath cycle, regions of severe atelectasis resistant to recruitment maneuvers are excluded from the ROI and thus not taken into account during EIT evaluation. Nevertheless, the equally-sized ROI approach can lead to misinterpretation in patients with a high body mass index since their ventilation activity in peripheral regions is negligible. Interpretation of EIT images may be further complicated due to the different color scales used by individual manufacturers since there is not a unified color scale. Ambiguities in analysis in time domain may be caused by continuous drift of the EELI values which can be misinterpreted as alveolar collapse. It is not always possible to distinguish whether the slow changes in EELI values are caused by slow development of lung aeration or by a steady drift of the EIT system.

EIT is an interesting method that can offer real time information about ventilation of the lungs. Nevertheless, as EIT is not in fact a true imaging modality, the provided information is dependent on the quality and the way of processing. As the processing may be complex, there are possible sources of errors that may impair the final results.

(Supported by grant VG 20102015062)