3D Electrical Impedance Tomography for Pulmonary Perfusion Defect Imaging: Is it possible with a 16 channel EIT system?

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Abstract

Pulmonary Embolism (PE) occurs when a blood clot, typically formed in the deep veins of the legs, thighs or pelvis (Deep Vein Thrombosis, DVT), travels to the lung and block the pulmonary arteries. PE and DVT are collectively known as Venous Thromboembolism (VTE). VTE is the fifth most probable cause of death in Australia in 2008. Approximately 56% cases of VTE is PE with 8253 Australians diagnosed with PE in 2008 alone. PE must be quickly and accurately responded with appropriate anticoagulant treatment. Nevertheless, the diagnosis of PE, especially in critically unwell patients who become haemodynamically compromised is an important issue that currently do not have satisfactory solutions. Electrical Impedance Tomography (EIT) has many advantages as a medical imaging modality. It is non–invasive, radiation–free, portable and inexpensive. This technique could be used for the diagnosis of pulmonary embolism. However, the current resolution of EIT is very low, rendering its sensitivity for perfusion defects not yet suitable for clinical application. In previous work, we have shown that performing EIT using 4 rings of 16 electrodes, placed equally on a simulated realistic FEM thorax model, pulmonary perfusion defects larger than 15% lung volume is observable. However, our EIT system, KHU Mark 2.5, is currently constrained to 16 electrodes. Thus, this research aims at investigating the applicability of using a 16 electrodes system for perfusion imaging. The simulations are performed using an FEM model of a male thorax (257 690 elements). The lungs regions are selected based on an extruded model with contours extracted from a CT slice at the lower chest region. The heart is simulated as an ellipsoid, located between the two lungs. Realistic conductivities of the corresponding tissues at 50 kHz are assigned to each region (inflated lung: 0.12 S/m, heart: 0.28 S/m). The heart conductivity is decreased by 3% and lungs conductivity is increased by 3% to simulate the effect of blood rushing from the heart to the lung at end cardiac systole. The perfusion defects regions are simulated as spheres within the lungs where the conductivity remains unchanged. With the constrain of 16 electrodes, we simulate and compare the results in the cases of using 2 rings of 8 electrodes and one ring of 16 electrodes in the upper and lower chest. The results showed that if the two rings are placed sufficiently close, using two rings of 8 electrodes provide better results, especially for out-of-plane defects, than using one ring of 16 electrodes. These results will be quantified using a series of test parameters, including amplitude, position error, resolution, shape deformation and ringing effects, which were proposed for the testing of GREIT algorithms. Future *in vivo* experiments on human subjects will also be performed to confirm the results of this study.

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