Mathematical and Numerical Modeling in Thoracic Electrical Bioimpedance Investigation.

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In general, thoracic bioimpedance procedures (TEB) provide electrical mappings of the cardiovascular activity obtained out of electrical measurements performed on the thorax. In particular, the heart and aorta hemodynamic activity may be accurately and non-invasively outlined by evidencing the change in the electrical conductivity of the blood, which is possible through the Electro Cardiometry (ECM) technique, a subset of the TEB procedures.

Mathematical modeling and numerical simulations (by the finite element method, FEM), in conjunction with image based reconstruction techniques are valuable tools in understanding the physical grounds of TEB, and the ECM in particular.

Our concern with the direct problem of ECM-TEB is related to assessing its sensitivity to the flow dynamics. Realistic 3D computational domains produced out of medical images by reconstruction techniques are needed as anatomy plays a key role.

Further more, available analytic formulae for the electrical conductivity of the blood obtained by experiments may not be easily (if possible) applicable if the aorta hemodynamic is modeled using anatomically realistic computational domains. This difficulty has to be solved and we propose the usage of an equivalent electrical conductivity based on averaging techniques, which is related to analytic results that outline the sensitivity of TEB to the blood flow dynamics.

Finally, the discrepancy between the time scales of the electric field and the hemodynamic flow in the ECM-TEB model requires a convenient way to solve these coupled problems. Two approaches are discussed and their results are compared.