Simulation of a Magnetic Induction Method for Determining Passive Electrical Property Changes of Human Trunk Due to Vital Activities

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Objective:
To evaluate the feasibility of a Magnetic Induction method for monitoring Breathing and Cardiac activity.

Methods:
The method is based on the creation of a primary magnetic field that will produce eddy currents in the trunk, these currents will produce a secondary magnetic field that has to be detected somewhere around the trunk [1]. This measured signal is a function of the conductivity and geometry of the tissue and the geometry of the excitation and detection antennas. For a sample of material between an excitation coil and a sensing coil:

$$\frac{\Delta B}{B} \propto \omega (\varepsilon_0 \varepsilon_r - j\sigma)$$

And using the Magnetic Fields interface, the main governing equations are:

$$B = \nabla \times A$$

$$\left( j\omega \varepsilon - \alpha^2 \varepsilon_0 \varepsilon_r \right) A + \nabla \times H = J_e$$

Results:
The induced eddy currents produced a secondary magnetic field, proportional to the properties of the tissues and the geometry. The secondary magnetic field detected at the same plane where the excitation coil is located, increases as frequency rises. Since the conductivity of lungs is lower when inflated, the secondary magnetic field is lower in this mode.

Conclusions:
Results show that the changes in the passive electrical properties of the lungs during breathing produce a noticeable change in the secondary magnetic field detected in the excitation plane. In addition safety issues have been studied to fulfill the international standards for limiting exposure to magnetic fields.

References: