

The Effect of Temperature on the Microwave Dielectric Properties of Porcine Liver, Lung, and Heart

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Recently, Microwave (MW) ablation emerged as a new technology with potential to eliminate the problems associated with RF ablation. In contrast to RF ablation, MW ablation uses higher frequencies (915 MHz and 2.4 GHz) and work on an electromagnetic energy propagation principle. When the microwave power is turned on, an antenna on the MW probe radiates electromagnetic energy into the tissue creating the ablation zone. As a result, MW ablation can be used for many organs such as lung and bones with higher impedance values where RF ablation would fail. Although microwave ablation therapy offers unique advantages over conventional radio frequency ablation therapy such as reduced ablation time, larger ablation zones, elimination of ground pads etc., there are still major problems associated with the existing microwave ablation devices on the market. Current devices use either dipole or slot antennas to deposit electromagnetic energy into the tissue. Such antennas are known to be very narrow band. During the design process, these antennas are matched to the tissue impedance at the frequency of operation (existing devices work at 915 MHz or 2.4 GHz). However, as soon as the microwave power is turned on, the electrical properties of the tissue (dielectric constant - ϵ_r and conductivity - σ) change due to increased temperature in the tissue. As a result, the power transmission characteristics of the entire system deteriorate. In order to better understand the power transmission characteristics of ablation antennas, we studied the microwave electrical properties of porcine liver, lung, and heart using the Agilent 805070 E slim form probe, a fiber optic temperature probe, and a smooth surface heat source. We manipulated the temperature from 25 °C to 80 °C and measured the dielectric properties between 500 MHz and 20 GHz.