Electrical Model for Radiofrequency Atrial Ablation Tools

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During radiofrequency ablation for atrial fibrillation, success critically depends on appropriate catheter tip/tissue contact. However, contact information cannot easily be obtained directly; it is often inferred from surrogate measures and may be imprecise. Therefore, the aim of this study was to investigate the relationship between catheter tip/tissue contact parameters, such as area of the contact surface, the angle of the tip against the tissue, and the impedance changes and voltage drops. We hope to optimize catheter tip/tissue contact to improve ablation efficacy. In order to make the procedure easier, the simulation was conducted in multiple parts: To begin, an ideal two-parallel-plate capacitor model with a homogeneous dielectric was constructed. Then, we filled half of the volume with a dielectric in different positions. Afterwards, we filled a half volume with a material, which had both permittivity and conductivity. We compared simulation with theoretical results to verify the accuracy of the model settings. We then considered a more realistic model of a semi-spherical tip inserted into a slab of tissue. We set different catheter tip/tissue contacts by changing areas and angles of incidence for the tip. Conclusion: Simulation results agreed well with theoretical. A larger permittivity produced a larger capacitance as expected. The deeper the tip went into the heart tissue, the larger the phase of the impedance of the whole model shifted.