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Cryosurgical treatment of cancer: The importance of modeling

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While there any many varied treatments for cancer, one emerging non-medical approach is the use of cryosurgery. Cryosurgery involves the freezing of tissues in order to cause their subsequent death. A standard protocol is complicated by the nature of cellular injury which is governed by complex biological mechanisms. For instance, tissue which is frozen very quickly results in intracellular ice formation and the subsequent damage to cellular membranes. Alternatively, for cases with slow freezing, the water is able to pass out of the cells and freezes in the extracellular spaces, thereby resulting in cell injury by dehydration. Regardless of the mechanism of cellular injury, for clinical settings it is essential that the treating physician is able to visualize the size, shape and position of the targeted area. When cryo-surgical probes are used in the treatment, their number, placement, temperature setting, and treatment duration are factors which determine the treated region. Here, we use advanced numerical simulation along with patient-specific kidney geometries. In the computational model, the tumors can be placed arbitrarily to match those of the patient. The software allows the treating physician to experiment with various techniques and to perfect the ultimate procedure in a virtual environment prior to real-life treatment. In this way, it is possible to more accurately target the tumor to ensure it is completely enclosed in the treatment zone meanwhile minimize the damage to nearby healthy tissue. The simulations can be carried out in less than four minutes so that their employment is not onerous to the physician.

Biography

John Abraham is a Professor at the University of St. Thomas in St. Paul, Minnesota. He has a 20-year career of medical device design, basic research, and litigation (burn injury and intellectual property expert). His research focuses on the application of heat transfer and fluid mechanics to various biomedical situations including treatment of benign and cancerous growths. He has in his name approximately 200 papers, conference presentations, books, and book chapters on applied and fundamental thermal sciences. He serves on the editorial board of many journals and has edited the Advances in Numerical Heat Transfer, Advances in Heat Transfer, and the Handbook of Numerical Heat Transfer. He also edited a special edition of *International Journal of Heat and Mass Transfer* focusing on biological applications of heat transfer. His technical area is thermal sciences which includes heat transfer and fluid mechanics applied to the human body. His recent projects involve scald injuries, cryosurgery, thermal ablation, neurostimulation, implanted medical device safety, catheter design, stem-cell treatments, cardiovascular disease and aneurysm assessment.

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