

Three-Dimensional Treatment Planning for Transrectal Ultrasound-Guided Cytolytic Adenoviral Gene Therapy Part II

The first generation virus is not uniformly distributed inside the target volume due the limited number of injection sites and a limited diffusion range. The structure in a tumor or an organ likely influences the viral distribution. With special attention to the rapid falloff of the doses at the limits of diffusion, a topological optimization is introduced to maximize the volume covered by the prescribed dose, to reduce high dose to the nearby tissue, and to minimize the numbers of injections and needles. The high dose region is determined by the injection uncertainty (5-mm diameter sphere from a single injection) and any cavity connected to the injection point. The cavities in prostate injection include the urethra, the bladder, and the needle punctures. The specific high dose outside the target volume indicates the wrong deposition or possible lost of the virus through the cavity. The prescribed 100% dose is the required viral concentration to “kill” the cancer cells. A convolution of the viral injections and the diffusion kernel determines the covered volume by the 100% dose. Ultimately, this topological optimization will allow us to automatically design an optimal pattern of injections and reduce the planning time such that the pre-plan imaging and the gene therapy delivery can be performed within the same system setup. This rapid dosimetry, planning, and treatment system is desired for gene therapy.