AbstractID: 14082 Title: Three-dimentional Dosimetric and Thermal Properties of a Newly Developed Ferromagnetic Core Thermobrachytherapy Seed for Treatment of Solid Tumors

Purpose: Studies of the curative effects of hyperthermia and radiation therapy on treatment of cancer show a strong evidence of a synergistic enhancement when two modalities are applied simultaneously. Varieties of tissue heating approaches developed up to date still fail to overcome such essential limitations as an inadequate temperature control, temperature non-uniformity, and prolonged time delay between hyperthermia and radiation treatments. We propose a new self-regulating Thermobrachytherapy seed, which serves as a source of both radiation and heat for concurrent administration of brachytherapy and hyperthermia.

Methods: The proposed seed is based on the BEST Model 2301-I^{125}, where tungsten marker is replaced with a ferromagnetic material. The ferromagnetic core produces heat when subjected to alternating electro-magnetic (EM) field and effectively shuts off after reaching its Curie temperature thus realizing the temperature self-regulation. We studied a model consisting 32 seeds, placed in the central region of a cylindrical water phantom. The temperature distribution thorough the volume surrounding the seeds was modeled using a finite-element partial differential equation solver package “COMSOL Multiphysics” for different EM field parameters.

Results: Temperature of the thermoseed surface rises rapidly and stays constant around Curie temperature of the ferromagnetic material (Cu-Ni alloy) used. The amount of heat produced by the ferromagnetic core is sufficient for raising the temperature of the surrounding volume to the therapeutic range. The volume of the therapeutic temperature range increases with increase of frequency or magnetic field. The temperature distribution is tunable based on the number of seeds used, their locations, magnetic field strength, and its frequency.

Conclusion:
The amount of heat produced by the seeds is sufficient for achieving the therapeutic temperature range in the surrounding volume when the appropriate frequency and magnetic field is applied. Our study demonstrates feasibility of the proposed combinational seed for clinical implementation of concurrent brachytherapy and hyperthermia.