AbstractID: 9176 Title: Comparison of Optical Diffusion Approximation and Delta P1 Approximation models for laser fluence in cancer treatment.

Purpose: Evaluation of competing optical models, the optical diffusion approximation (ODA) and delta P1 approximation for use in ablative laser cancer treatment of nanoparticles impregnated tumors. **Method and Materials:** Gold-coated, silica-core nanoshells, core diameter 180nm were placed in 1.5 wt% agar gel phantoms with nanoshell concentrations of $1.19x10^9$ nanoshells/mL and $2.53x10^9$ nanoshells/mL . Phantoms were cylindrical, 23 mm wide by 69 mm high and heated using laser powers of 0.64, 0.8 and 1.2Watts with 0.5cm spot size. Thermal images of heating were obtained using MRTI on a clinical 1.5 T MRI (Excite, HD, GE Healthcare Technologies, Waukesha, WI). MRTI uses a 2D fast, spoiled, gradient-echo sequence, with field of view = 12 cm, slice thickness = 3 mm, matrix = 256 x 128, TR/TE = 74.5 ms/15 ms, FA = 30°. MRTI utilized the complex phase difference method to calculate temperature images, one image every 5 seconds for 300 seconds. Modeling the thermal response was performed with a finite element solution of the nonhomogenous heat equation using commercial software (Comsol Multiphysics®, Comsol Inc., Burlington, MA, U.S.).
Results: For the $1.19x10^9$ nanoshells/mL phantom both ODA and delta P1 give similar results with delta P1 being better overall, root mean square (RMS) difference between experiment and the model was 3 times greater for ODA than delta P1. For the higher concentration gel ($2.53x10^9$ nanoshells/mL) the RMS difference between experiment and the model was 4 times greater in the case of ODA compared to delta P1 with ODA failing to describe the experimental data in any adequate way. The greater accuracy of the delta P1 is attributed to its treatment of scattered and unscattered components of the light as separate entities.
Conclusion: ODA works for lower nanoshell concentrations, but breaks down at higher concentrations. Delta P1 works well for all concentrations tested.