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PII: S0306-4565(16)30243-1
DOI: http://dx.doi.org/10.1016/j.jtherbio.2016.11.016
Reference: TB1852

To appear in: *Journal of Thermal Biology*

Received date: 9 August 2016
Revised date: 17 November 2016
Accepted date: 21 November 2016

Cite this article as: Simão Nóbrega and Pedro J. Coelho, A PARAMETRIC STUDY OF THERMAL THERAPY OF SKIN TISSUE, *Journal of Therma Biology,* http://dx.doi.org/10.1016/j.jtherbio.2016.11.016

A PARAMETRIC STUDY OF THERMAL THERAPY OF SKIN TISSUE

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ABSTRACT

A thermal therapy for cancer in skin tissue is numerically investigated using three bioheat conduction models, namely Pennes, thermal wave and dual-phase lag models. A laser is applied at the surface of the skin for cancer ablation, and the temperature and thermal damage distributions are predicted using the three bioheat models and two different modeling approaches of the laser effect. The first one is a prescribed surface heat flux, in which the tissue is assumed to be highly absorbent, while the second approach is a volumetric heat source, which is reasonable if the scattering and absorption skin effects are of similar magnitude. The finite volume method is applied to solve the governing bioheat equation. A parametric study is carried out to ascertain the effects of the thermophysical properties of the cancer on the thermal damage. The temperature distributions predicted by the three models exhibit significant differences, even though the temperature distributions are similar when the laser is turned off. The type of bioheat model has more influence on the predicted thermal damage than the type of modeling approach used for the laser. The phase lags of heat flux and temperature gradient have an important influence on the results, as well as the thermal conductivity of the cancer. In contrast, the uncertainty in the specific heat and blood perfusion rate has a minor influence on the thermal damage.

Keywords: Bioheat equation; Thermal therapy; Skin tissue; Non-Fourier heat conduction; Thermal damage