Numerical prediction of the intracellular ice formation zone during cryosurgery on a nodular basal cell carcinoma using liquid nitrogen spray

F. Sun[1], L. Martínez-Suástegui[2], G.-X. Wang[3], K.M. Kelly[4], and G. Aguilar[1,*]

[1]*Department of Mechanical Engineering, University of California, Riverside, CA 92521, USA*

e-mail: gaguilar@ucr.engr.ucr.edu

[2]*ESIME Azcapotzalco, Instituto Politécnico Nacional, Avenida de las Granjas No. 682, Colonia Santa Catarina, Delegación Azcapotzalco, México Distrito Federal 02250, Mexico*

[3]*Department of Mechanical Engineering, University of Akron, OH 44325, USA*

[4]*Beckman Laser Institute, University of California, Irvine, CA 92612, USA*

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ABSTRACT

Cryosurgery is a surgical technique that employs freezing to destroy target tumor tissue. While the main objective during a cryosurgical procedure is to ensure tissue destruction within the cryolesion, the greatest challenge is on how to spare the surrounding healthy tissues from cryoablation. In this work, a historical review of the field of cryosurgery is presented followed by a theoretical study where a mathematical model is developed for cryosurgery on a basal cell carcinoma (BCC) using liquid nitrogen (LN_2) spray. The model takes into consideration the anatomic structure of skin tissue and the irregular geometry of BCC. In particular, a methodology for quantitatively determining the extent of the intracellular ice formation (*IIF*) zone based on the tissue temperature and cooling rate (CR) is proposed, which can directly relate to the necrosis of the cancer cells after cryosurgery. The model is then used to analyze formation of the *IIF* zone during cryosurgery on a BCC and quantification is provided for the volume of the final *IIF* zone. A parametric study is also carried out to investigate the effect of various protocol parameters on the final *IIF* zone. The results should be useful for dermatologists for pre-treatment surgery planning.

NOMENCLATURE

a	dimensionless constant from regression
b	dimensionless constant from regression