Modeling and Measurement of Heating Patterns of a HIFU Applicator: preliminary results

Raquel Martinez¹, A. Ramos², A. Vera³, L. Leija³

¹Department of Biomedical Engineering, Polytechnic University of Chiapas, Chiapas, Mexico, ²Group of R&D "Systems and Ultrasonic Technologies", Institute for Physical and Information Technologies, CSIC, Madrid, Spain, ³Electrical Engineering Department, Bioelectronics Section, CINVESTAV-IPN, Mexico City, Mexico

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It is well known that, in focused ultrasonic systems, the radiated beams through tissues converge around a focal point. This phenomenon produces a temperature increment over 56°C in few seconds, at the focus by the mechanical waves energy transformation into heat, due to acoustic absorption in the tissue. This can originate thermal coagulation, instantaneous cell damage or instantaneous ablation [1]–[3]. These possible effects make high-intensity focused ultrasound (HIFU) a suitable therapeutic tool for delivering localized energy to treat benign and malignant tumors in a non-invasive way without damaging surrounding tissues. A previous study reported that by adding a conical applicator, HIFU energy could be delivered more efficiently, thus notably reducing the electrical power needed to drive the device and reaching haemostasis temperatures [4], [5]. Besides, results from both, acoustic propagation modeling and ultrasonic characterization of this applicator, are necessary, previously to accurately investigate the resulting heating patterns created by this HIFU device. The aims of this work are to obtain a simulated heating pattern by means of finite element method (FEM) modeling and also to measure the applicator surface temperature with an infrared camera. First, ultrasonic propagation was performed in order to use their resulting data as inputs for the heating modeling. Then, for the experimental comparison, the ultrasonic device was driven with only 20 W during 120 s and thermographic pictures (using model Ti32, Fluke Corporation®) were taken every 15 s for the conical emitting surface. Preliminary results have shown that in both, simulated and experimental analyses, the heating concentrates around the focal point; however, thermographic images depicted a slightly larger heating area over the applicator surface, probably due to ultrasonic non-linear propagation, and some fast thermal diffusion.