Journal of Acoustical Engineering Society of Iran, vol. 3, no. 1, 2015

Estimation of ultrasound pressure distribution due to 1 MHz ultrasonic transducer for ultrasonic treatment planning in hyperthermia methods

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Abstract

One of cancer's therapeutic methods is applying ultrasound induced hyperthermia independently or in combination with other therapeutic methods like radiotherapy and chemotherapy. Because of improper distribution of sonication in tissue under treatment and not achieving to a suitable treatment planning during sonication, tissue temperature do not regulate correctly. So in this study to achieve ultrasonic treatment planning protocol, Rayleigh integral has been used for modeling propagation of sound. In this study, Rayleigh integral for two 1 MHz ultrasonic transducers have been solved in cylindrical coordinates for the purpose of estimating effects of 0.8 and 5.0 cm^2 effective radiation area and different intensities. Ultrasonic pressure distribution in axial, radial and angular directions were extracted. For validation of modeling results, acoustic pressure value in aqueous medium and at specific distances from transducer face has been measured using piston hydrophone. The results show that there are good agreement between modeling results and experimental measurements with 0.82 correlation of coefficient (p-value<0.05). The mean relative error is 7.34 percent for 5.0 cm^2 effective radiation area with 1.5 to 14.2 percent interval. It is concluded that this model is capable of modeling sound propagation in tissue and performing first step in hyperthermia treatment planning with acceptable accuracy.

Keywords: Ultrasound waves, Modeling, Rayleigh Integral, Effective radiation area, Hyperthermia

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[DOR: 20.1001.1.23455748.1394.3.1.6.6]

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