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Estimation of mechanical index distribution of low intensity ultrasound waves in cell studies

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Abstract

Considering the use of mechanical stimulation such as low-intensity ultrasound for proliferation and differentiation of stem cells, it is essential to understand the physical and acoustical mechanisms of acoustic waves in vitro**.** In this study, modeling of the mechanical index (MI) was applied to provide treatment protocol and to understand the effective physical processes on reproducibility of stem cells. The acoustic pressure and mechanical index equations are modeled and solved to estimate optimal mechanical index for kHz and MHz frequencies for continuous exposure mode, transducer and the culture environment area in cylindrical coordinates. Based on the results of the axial and radial pressure distributions, regions with 0.7 mechanical index (cavitation threshold), more and less than threshold of induced cavitation were identified for extracting of radiation arrangement to cell medium. In order to validate the results of the modeling, the acoustic pressure in the water and near field depth was measured by a piston hydrophone. Results of modeling and experiments show that the model is consistent with the experimental results of those having correlation coefficients of 0.91 and 0.90 ($p<0.05$) for 1 MHz and 40 kHz transducer, respectively .

Keywords: Treatment planning, Ultrasound waves, Mechanical index, Cell study.

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