

Comparison of subharmonic spectrum analysis and chemical dosimetry in measurement of cavitation activity

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Abstract

Currently several therapeutic applications of ultrasound in cancer treatment are under progress which uses cavitation activity to deliver their effects. There are several methods to evaluate cavitation activity such as chemical dosimetry and measurement of subharmonic signals. In this study, the cavitation activity induced by the ultrasound irradiation and the effect of exposure parameters on it has been measured by terephthalic acid chemical dosimetry and subharmonic analysis. Experiments were performed in the 1 MHz field in the progressive wave mode and effect of changing duty cycles in constant intensity ($I_{SATA}=2$ W/cm²) and changing acoustic intensity in continuous mode on both fluorescence intensity and subharmonic amplitude were measured. The correlation between fluorescence intensity of terephthalic acid chemical dosimetry and subharmonic amplitude of spectrum analysis were determined by Pearson correlation ($p<0.05$). It has been shown that the subharmonic amplitude and the fluorescence intensity in continuous mode is higher than pulse mode ($p<0.05$). Also it was shown that there is a significant difference between the subharmonic amplitude and the fluorescence intensity in different sonication intensities ($p<0.05$). A significant correlation between the fluorescence intensity and subharmonic amplitude at different duty cycles ($R=0.99$, $p<0.05$) and different intensities ($R=0.99$, $p<0.05$) were shown. The subharmonic amplitude (μ V) significantly correlated with the fluorescence intensity (count) ($R=0.90$, $p<0.05$) and the fluorescence intensity due to chemical dosimetry could be estimated with subharmonic amplitude due to subharmonic spectrum analysis. It is concluded that there is dependence between terephthalic acid chemical dosimetry and subharmonic spectrum analysis in determination of acoustic cavitation activity.

Keywords: Ultrasound, Inertial cavitation, Subharmonic analysis, Terephthalic acid dosimetry, Correlation