

عنوان مقاله:

A Numerical Investigation of the Time Reversal Mirror Technique for Trans-skull Brain Cancer Ultrasound Surgery

محل انتشار:

مجله فیزیک پزشکی ایران، دوره 4، شماره 1 (سال: 1386)

تعداد صفحات اصل مقاله: 10

نویسندگان:

H. Zahedmanesh - M. Sc. Student of Biomechanical Engineering, Sahand University of Technology, Tabriz, Iran

F. Ghalichi - Associate Professor, Biomechanics Division, Sahand University of Technology, Tabriz, Iran

S. Behnia - Assistant Professor, Department of Physics, Islamic Azad University, Ourmia, Iran

خلاصه مقاله:

Introduction: The medical applications of ultrasound on human brain are highly limited by the phase and amplitude aberrations induced by the heterogeneities of the skull. However, it has been shown that time reversing coupled with amplitude compensation can overcome these aberrations. In this work, a model for 2D simulation of the time reversal mirror technique is proposed to study the possibility of targeting any point within the brain without the need for craniotomy and to calculate the acoustic pressure field and the resulting temperature distribution within the skull and brain during a High Intensity Focused Ultrasound (HIFU) transcranial therapy. **Materials and Methods:** To overcome the sensitivity of the wave pattern to the heterogeneous geometry of the skull, a real MRI derived 2D model is constructed. The model should include the real geometry of brain and skull. The model should also include the couplant medium which has the responsibility of coupling the transducer to the skull for the penetration of ultrasound. The clinical substance used as the couplant is water. The acoustic and thermal parameters are derived from the references. Next, the wave propagation through the skull is computed based on the Helmholtz equation, with a 2D finite element analysis. The acoustic simulation is combined with a 2D thermal diffusion analysis based on Pennes Bioheat equation and the temperature elevation inside the skull and brain is computed. The numerical simulations were performed using the FEMLAB 3.2 software on a PC having 8 GB RAM and a 2.4 MHz dual CPU. **Results:** It is seen that the ultrasonic waves are exactly focalized at the location where the hydrophone has been previously implanted. There is no penetration into the sinuses and the waves are reflected from their surface because of the high discrepancy between the speed of sound in bone and air. Under the focal pressure of 2.5 MPa and after 4 seconds of sonication the temperature at the focus reached 51 °C and the temperature of the pre-target bone increased to 56.31 °C. In the post-target region the temperature of the sphenoid bone increased to 47.1 °C while the temperature of the occipital bones reached up to 46 °C. It is also shown that by using a cold water cooling system and cooling down the pre-target bones to 20 °C before sonication, the maximum pre-target bone temperature will not exceed 40 °C and hence the pre-target bone cells will remain intact. **Discussion and Conclusion:** In this study, it is well demonstrated that ... by using the time reversal mirror technique it is possible to target any point

کلمات کلیدی:

High Intensity Focused Ultrasound, brain tumor, Ultrasound thermotherapy, finite element method

لینک ثابت مقاله در پایگاه سیویلیکا:

