

Novel Approach to Apply Focused Ultrasound for Brain Disease

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Abstract :

The concept of focused ultrasound (FUS) and its application in the field of medicine have been suggested since the mid-20th century. The first trial for functional diseases was started in 2010, and the results were successful to make lesion in the target area. Nowadays, the indication of FUS treatment for functional brain diseases is gradually widening, and many trials using the FUS technique are reporting good results. In addition to the lesioning technique, the possibility of clinical application of low intensity FUS to brain disease treatment has been investigated at a pre-clinical level, and it is expected that FUS treatment will become one of the most important novel techniques for the treatment of brain diseases in the near future.

Besides thermal ablation of brain tissue, various biological effects of FUS have been investigated. One of these regards its neuromodulatory effects. There is some evidence for changes in neuronal functions when neurons receive ultrasonic energy. Several postulations have been made regarding the mechanism underlying the neuromodulatory effect of FUS including the hypothesis that FUS might change the permeability of mechano-sensitive calcium channel receptors. It seems to be true that low intensity, pulsed FUS sonication can modulate neuronal function non-invasively. However, further investigation is needed for human application.

Another interesting biological effect of FUS sonication is related to stem cell homing. Recently, it was observed that stem cells injected into blood vessels migrated to the area adjacent to an FUS sonication target

region. This phenomenon was also detected in the brain. Although further research is necessary, it is anticipated that stem cell application in CNS diseases could be tremendously widened if the transplantation area could be non-invasively modulated by FUS sonication.

Finally, the application of FUS in the treatment of neurodegenerative diseases, especially Alzheimer's disease (AD) is considered. Interestingly, amyloid plaques within the sonication area were diminished compared to the non-treated area. Behavioral tests also showed some improvement in the FUS treated group. Although this phenomenon should be verified through further investigation, it might be possible to apply FUS treatment to AD patients in the future.

Keywords :

Brain, Neuroscience, Focused Ultrasound, Therapeutic