Experimental Study on Transcranial Magneto-Acoustic Coupling Stimulation

Xiaoqing Zhou, Huiqin Wang, Ren Ma, Tao Yin, Zhuo Yang, and Zhipeng Liu

Abstract In this paper, we present a novel electrical stimulation method, which can achieve high spatial resolution electrical stimulation in the deep brain region. We name it transcranial magneto-acoustic stimulation (TMAS) method. In this study, we obtained a 2 mm spatial resolution TMAS system and applied this neuromodulation technique to hippocampal stimulation in living mice for the first time. The effect of TMAS has been evaluated and analyzed. Firstly, the magneto-acoustic (MA) coupling electric field generated by TMAS was calculated by theoretical model. The TMAS experimental system for small animals was built, and its MA electric fields were tested. The results showed that the TMAS system can obtain the spatial resolution of 2 mm both in the cortex and hippocampus of the mouse. Next, the system was used to conduct TMAS in vivo experiments in healthy and PD mice, and the stimulation location was the hippocampus. Because the transcranial ultrasonic stimulation (TUS) is inevitably involved in the TMAS process, we added the TUS group with the same parameter on the basis of the TMAS group and the control group to explore the effect of the focused ultrasound field on the TMAS. We used behavioral and electrophysiological data to assess the effects of nerve stimulation on each group of mice. The experimental results showed that the learning and memory abilities of

X. Zhou (✉) · H. Wang · R. Ma · T. Yin · Z. Liu
Chinese Academy of Medical Sciences & Peking Union Medical College Institute of Biomedical Engineering, Tianjin 300192, China
e-mail: xiaoqing-lingjun@163.com

H. Wang
e-mail: whq186235@163.com

R. Ma
e-mail: likesaber@gmail.com

T. Yin
e-mail: bme500@163.com

Z. Liu
e-mail: lzpeng67@163.com

Z. Yang
College of Medicine, Nankai University, Tianjin 300071, China
e-mail: zhuoyang@nankai.edu.cn

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the healthy-TMAS group and the PD-TMAS group mice were significantly better than those of the control groups, respectively, which verified the safety and usefulness of the TMAS method. Moreover, it was found that the learning and memory abilities of the TUS group mice, include healthy and PD group, were also better than those of the control groups, but far less than those of the TMAS groups, respectively, which verified the contribution of ultrasound field in TMAS. It can be seen that TMAS is actually a compound stimulation containing two orthogonal physical fields: the MA electric fields and the ultrasound field. And the assessment of TMAS proposes should consider the bioelectric effect and the mechanical force.