Research Center for Medical Sciences Division of Ultrasound Device Development and Application

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Research Activities

Outline of education and research

1. Research on the development of a breast ultrasound diagnostic support system by deep learning

In this study, we aim to develop a diagnostic support system using deep learning, a type of machine learning, to determine benign or malignant characteristics of B-mode mammary ultrasound images by means of artificial intelligence (AI). Required for this study are more than 1,000 ultrasound mammary images (data for teacher training) from cases with pathological diagnostic results, and we are currently developing an AI with the approval of the university's ethics committee to collect cases and install a deep learning program. This study is expected to improve the diagnostic efficiency of breast ultrasound examiners.

2. Development of computer system for AI development

Japan Agency for Medical Research and Development (AMED), Research on the construction of a national database of digital ultrasound images and the development of an artificial intelligence-assisted ultrasound diagnosis system, adopted in the "ICT Infrastructure Construction and Artificial Intelligence Implementation Research Project for Clinical Research, etc." in FY2019 (principal investigator: Dr. Kudo, president of the Japanese Society of Ultrasound Medicine) As a research participant, we are working on the development of ultrasound image processing and prototype diagnostic support. In this fiscal year, as a study of AI transfer learning effects using image sets from other fields, we are evaluating the effects of transfer learning using various image data sets and preparing computer hardware and software environments for the development of artificial intelligence.

3. Educational activities to promote AI application in diagnostic imaging

We educated the members of the Japan Society of Ultrasonography and the Japan Society of Radiology about the future of AI applications and the principles of its application for supporting diagnostic radiology. We also wrote and published articles in the *Journal of the Japanese Society of Nephrology* and the *Journal of the Society for Medical Imaging Information*.

4. In vitro study of ultrasound combined with microbubbles for rapid resumption of acute critical vessel occlusion

Early reopening of the occluded vessel is the most fundamental treatment for acute stroke. Transcranial ultrasound and microbubbles have been shown to promote thrombolysis of recombinant tissue-type plasminogen activator (rt-PA). However, the frequent failure of

clinical thrombolysis of completely occluded vessels is thought to be due to the difficulty or inability of rt-PA itself to reach the site of the thrombus in a vessel that has completely stopped blood flow. We have theoretically demonstrated that the combination of ultrasound and microbubbles may not only promote local acceleration of rt-PA thrombolysis, but also have a long-distance delivery effect on rt-PA. In the present study, we are investigating the existence and magnitude of this delivery effect and its relationship to various ultrasound parameters through in vitro experiments. We are also investigating the precise optical measurement of microbubble size to validate the simulation study.

5. Study on the prevention of vascular occlusion by ultrasound

Vascular reocclusion often occurs immediately after hyperacute vascular reopening, i.e., rt-PA treatment after the onset of cerebral vascular embolism. Vascular reocclusion is a critical problem because anticoagulation is prohibited within 24 hours after rt-PA treatment. In this study, investigators have shown that noninvasive ultrasound can control thrombus growth. Safe and simple ultrasound irradiation could be used to prevent reocclusion after rt-PA treatment for hyperacute stroke, and basic research is underway for further clinical applications.

6. Research Department Name Change in the Next Fiscal Year (FY2020)

Since the establishment of the Ultrasonic Technology Research Division in April 2015, we have taken over the research on the application of ultrasound to the treatment of brain infarction from the former Medical Engineering Research Division (MERI). However, due to the changes in research after that, most of the research in our department has been focused on artificial intelligence in medicine, and both Grant-in-Aid for Scientific Research (KAKENHI) 1 and AMED 1 of the public research funds (KAKENHI 2 and AMED 1) that our department currently receives are for research on artificial intelligence. has become a research theme. Nowadays, researches on artificial intelligence other than ultrasound have been increasing, such as research activities of AI-related societies such as the Japanese Medical AI Society (Nakata) and the Japanese Society for Medical Imaging Engineering (Nakata), and the researches on artificial intelligence in medicine including ultrasound have become the research subjects and targets of our division. Therefore, from April 1, 2020, the name of our laboratory will be changed from “Ultrasound Science and Development” to “Artificial Intelligence Laboratory.”