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

Norio Nakata, *Director and Associate Professor* Zuojun Wang, *Assistant Professor*

Research Activities

Education/Research outline

1. Development of decision supporting system of breast ultrasound using deep learning

The purpose of this study is to develop decision supporting system of breast ultrasonography using deep learning which is one of machine learning techniques. The goal of this system is a classification tool between benign and malignant breast mass lesions. For this study, at least 1,000 cases of supervised data sets including breast ultrasound images and pathologic diagnosis results are required. This study has already approved by the Jikei University Ethics Committee. We are preparing the installation of the deep learning program and the experiment of AI tests. Improvement of diagnostic efficiency of breast ultrasound diagnostic radiologists is expected by this study.

2. Improvement of computer hardware and software environment for AI development

In Japan Agency for Medical Research and Development (AMED) 2017: "Clinical research etc. ICT infrastructure building · Artificial intelligence implementation research project" Adoption of secondary public offering (medical productivity revolution realization project), utilization of artificial intelligence (Research Representative: Masatoshi Kudo, President of the Japan Society of Ultrasonic Medicine), Norio Nakata, MD has developed ultrasound image processing and prototype diagnosis support as research contributors. In this first year, as a study of AI transfer learning effect using images of other areas, we developed an AI algorithm for judging chest disease using chest X-ray photograph (over 100,000 sheets) published at NIH In order to prepare for the development of the environment of computer hardware and software for artificial intelligence development.

3. Education and awareness activities to promote AI utilization in diagnostic radiology

In the Japan Society of Ultrasonic Medicine and the Japan Radiological Society, we conducted education and awareness activities to explain the future of AI utilization to the near future imaging support and its principle to academic members (ultrasonic specialists and radiologists). Norio Nakata wrote and published its contents in the Journal of the Japanese Society of Nephrology and the Journal of Medical Image Information Society.

4. In vitro study on method of fast reopening of acute occluded vessels with ultrasound and microbubbles

Early reopening of occluded blood vessels is the most effective treatment for acute cerebral infarction. It has already been proved that transcranial ultrasound or its combination with microbubbles can promote thrombolytic efficiency of recombinant tissue type plasminogen activator (rt-PA). However, clinically failed cases of thrombolytic therapy fre-

quently occurred in completely occluded cerebral arteries, the cause of which is thought to be that rt-PA itself is hard to reach the thrombus site when blood flow is completely stopped. We theoretically examined and demonstrated that the combined use of ultrasound and microbubbles may have the effect of transporting rt-PA over a long distance, in addition to its local promoting action on rt-PA thrombolysis. In this study, we are conducting research on the existence and amplitude of this transportation effect and its relationship with various parameters of ultrasound through in vitro experiments.

5. Study on prevention method of vascular re-occlusion by ultrasound

Re-occlusion of blood vessels occurs frequently after thrombolytic therapy with intravenous rt-PA. Because anticoagulation therapy is prohibited within 24 hours after rt-PA treatment, vascular reocclusion is a fatal problem. Together with Lecturer Sawaguchi (Faculty of Biomedical Engineering, Toin University of Yokohama), we are conducting research on the thrombus growth control effect of noninvasive ultrasound with an in vitro clot growth model. This study showed that noninvasive ultrasound irradiation can control thrombus growth. It is considered that safe and simple ultrasonic irradiation can be used to prevent re-occlusion after rt-PA treatment for acute cerebral infarction. Further advanced basic researches are being conducted toward clinical application.

Inspection and Evaluation

The research presentations and scientific papers are listed as follows.

Publications

Wang Z, Sawaguchi Y, Hirose H, Ohara K, Sakamoto S, Mitsumura H, Ogawa T, Iguchi Y, Yokoyama M. An In Vitro Assay for Sonothrombolysis Based on the Spectrophotometric Measurement of Clot Thickness. *J Ultrasound Med.* 2017; **36:** 681-98.

Wang Z, Komatsu T, Mitsumura H, Nakata N, Ogawa T, Iguchi Y, Yokoyama M. An uncovered risk factor of sonothrombolysis: Substantial fluctuation of ultrasound transmittance through the human skull. *Ultrasonics.* 2017; **77:** 168-75.

Shiraishi K, Wang Z, Kokuryo D, Aoki I, Yokoyama M. A polymeric micelle magnetic resonance imaging (MRI) contrast agent reveals blood-brain barrier (BBB) permeability for macromolecules in cerebral ischemia-reperfusion injury. *J Control Release.* 2017; **253:** 165-71.

Wang Z, Yokoyama M, Nakata N, Sawaguchi K. Quantitative Evaluation of Thrombolysis Enhancing Effect in Vitro of Ultrasound Combined with Microbubbles. *Ultrasonic Technology.* 2017; **29:** 72-7.