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Photoacoustic Lymphangiography

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Objectives: Photoacoustic lymphangiography (PAL), which is based on photoacoustic

(PA) technology, is an optical imaging that visualizes the distribution of light absorbing tissue components like hemoglobin or melanin, as well as optical absorption contrast imaging agents like indocyanine green (ICG) in the lymphatic channels, with high spatial resolution. In this report, we introduce the three-dimensional images of human lymphatic vessels obtained with PAL.

Materials and Methods: We used the PAI-05 system with semi-spherical detector array, which was made by Canon Inc. (Japan), Hitachi, Ltd. (Japan) and Japan Probe Co, Ltd. (Japan). Twenty healthy subjects and 30 lymphedema patients were recruited. To image the lymphatic structures of the limbs ICG was administered subcutaneously to the dorsal aspect of each foot or hand as in fluorescence lymphography. PA images were acquired by irradiating the tissue using a laser at wavelengths of near-infrared region. On the same occasion, fluorescence images were also recorded.

Results: The lymphatic vessels up to the diameter of 0.2 millimeters could be observed three-dimensionally with the venules around them in the still images. In the patient-group, dermal backflow patterns were often observed as dense interconnecting three-dimensional structures of lymphatic vessels. Extended or twisting collecting vessels passing below the fine complex network of dermal lymphatics were also observed, which were not observed by fluorescence lymphography. In the videos, lymphatic pump was observed intermittently with various intervals. It was difficult to detect the lymphatic flow in the patients because the lymphatic fluids in the channels are stagnated.

Conclusions: PAL provided the detailed observation of each lymphatic vessel, leading to deeper understanding of three-dimensional structures and physiological state of the vessel. With this technology, many portions of the black boxes in the field of lymphedema surgery will be opened.