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Photoacoustic Imaging for the Planning and Postoperative Assessment of Lymphaticovenular Anastomosis

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Objectives: Several imaging modalities, including indocyanine green (ICG) fluorescent lymphography, ultrasound, and MRI, can be used for both preoperative and postoperative evaluation of lymphaticovenular anastomosis (LVA); however, they are limited as they cannot provide accurate information about the lymphatic vessels and venous system. Photoacoustic (PA) imaging can visualize the distribution of light absorbing molecules, such as hemoglobin or ICG, and simultaneously provide three-dimensional images of superficial lymphatic vessels and the venous system. In this study, we planned LVA and analyzed the effect based on PAI-derived information.

Materials and Methods: PAI lymphangiography was performed using the PAI-05 system on three patients (2 men, 1 woman) with lymphedema, including one primary case and two secondary cases, before and after LVA. In all cases, we preoperatively determined an incision site where the lymphatic vessels were adjacent to venules based on PA images. In addition, postoperative images obtained at from one week to five months after LVA, were compared with preoperative images.

Results: During LVA, we found the lymphatic vessels and venules to be at the site corresponding to that shown in the PA images in all cases, enabling us to perform LVA as planned. In the postoperative PA images, we observed morphologic changes in the lymphatic vessels and venules resulting from LVA. In all cases, the lymphatic vessels became dilated, and the diameter of the veins tended to decrease overall after LVA. Furthermore, postoperative PA images showed more lymphatic vessels than preoperative images.

Conclusions: PAI provided accurate anatomical information of each lymphatic vessel and venule, which was useful in locating them during the surgery and shortening the

operation time. It also showed changes in the morphologic features of the lymphatic vessels and venules after LVA. Therefore, we suggest that PAI is a promising imaging technique for LVA planning and evaluation, and for postoperative monitoring of improvements.