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INTRODUCTION: Complications associated with venous microcirculation remains prevalent to autologous reconstruction with the free deep inferior epigastric artery perforator (DIEP) flap. It has been previously been demonstrated that retaining the dermal component in DIEP flap harvest has a significant role in overall flap perfusion. Studies of venous perforator anatomy and assessment of perforator vascular territories (venosomes) has not received the same attention compared to arterial studies. This study evaluates the venous microcirculation of the anterior abdominal wall integument of the DIEP and superficial inferior epigastric venous systems and the impact on the dermis on venous microvascular perfusion.

METHODS: Fourteen hemi-abdominal flaps from the midline to mid-axillary line were harvested in fresh, non-frozen human cadavers. Following perforator mapping, the venae comitantes of the largest DIEP perforator and the superficial inferior epigastric vein cannulated using a 27-gauge butterfly catheter. Flaps were evaluated with high resolution computed tomography (CT) following injection of iodinated contrast (Omnipaque ®) to the DIEP venae comitantes and SIEV. The contrast agent was flushed out from the flap between injections. The dermis was subsequently removed with cautery at the subdermal dissection plane and flaps were re-imaged with CTA following injection in the DIEV perforator. Three-dimensional CT angiography of the venous territories allowed detailed assessment at each stage including perfusion areas, volume and pattern of perfusion.

RESULTS: Average territory of the largest DIEV perforator was 180cm² and extended to 47% of the hemi-abdominal integument. Patterns of venous territory distribution from individual venous perforators were assessed in hemi-abdominal flaps of the anterior abdomen. The perfusion territory without the dermis was significantly reduced by a mean of 142cm², P=0.01. Mean volume of perfusion was significantly reduced on average by 10cm³, P=0.01. A direct communication of the DIEV perforator with the superficial system was seen in 10/14 flaps (71%).

CONCLUSION: Venous microcirculation plays a critical role in success of DIEP flap harvest. This study details patterns of venosomes of DIEV perforators, the comparison with the superficial system but appreciates the critical role of the preservation of the dermal integrity to preserve and optimize venous drainage of the flap by avoiding aggressive de-epithelialization.

Preliminary Experience with High-Resolution 3D Lymphangiovenulography: The First Success in Video Recording of the Lymphatic Pumping Using Photoacoustic Imaging in Man

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PURPOSE: Photoacoustic imaging (PAI), which is based on photoacoustic (PA) technology, is an optical imaging that can image the distribution of light absorbing tissue components like hemoglobin or melanin, or optical absorption contrast imaging agents like Indocyanine green (ICG), with high spatial resolution. The visualization of lymphatic system in mice with PAI technique has been demonstrated in previous report, however, human lymphatic vasculature has not been visualized because the penetration depth was limited. Recently, our group has reported PAI analysis of tumor-associated vasculatures in human breast cancer or palmar blood vessels. In this report, we introduce a new imaging technique of PA lymphangiovenulography to visualize human lymphatic vessels in three dimensions in detail.

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). To image the lymphatic structures of the limbs in 4 healthy subjects, ICG was administered subcutaneously dorsal aspect of each foot or hand (some web spaces). A PA image was acquired by irradiating the
Results: In the still images, the lymphatic vessels up to the diameter of 0.2 millimeters could be observed three-dimensionally with the blood vessels around them. In the videos, it was observed that lymphatic fluid including ICG was transported by spontaneous contraction of the collecting lymph vessels. The flow was observed intermittently with various intervals. The velocity of the flow was also varied from subject to subject. Lymph flow tended to be faster in the upper limbs than in the lower limbs.

Conclusion: In this study, three-dimensional high spatial and temporal resolution PA images were obtained using the PAI-05 system, allowing the visualization of fine lymphatic vasculature and its pumping movement. The system is a promising tool for more precise quantitative assessment of the pumping frequency and the velocity in the collecting lymphatic vessels in lymphedema patients or subclinical subjects.

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A Clinical Trial for Three-Dimensional Vascular Mapping of Anterolateral Thigh Flap Distally-Branching Perforator Vessels Based on Photoacoustic Tomography: The Protocol and Preliminary Results

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Background: Thin free flaps are challenging procedures. In particular, the failure of thin anterolateral thigh (ALT) flaps is reported to be associated with the distal branching pattern of the perforator vessels. In a previous study, we demonstrated the feasibility of using photoacoustic tomography (PAT) to identify ALT perforators and their branching patterns in the subcutaneous layer, especially those in oblique or horizontal orientations. In this paper, we present the protocol and preliminary results of a clinical trial for three-dimensional vascular mapping of the distal ALT perforators using PAT imaging.

Methods: Patients for whom reconstructive surgery using an ALT flap was planned were recruited. Four days before the operation, the bilateral anterolateral aspects of the mid-thigh were examined by PAT. The perforator orientation, as determined by ultrasound, was marked with red ink. The body surface was marked every 4 cm with purple ink. The acquired data were processed three-dimensionally using a laboratory-made imaging software program. The depth of the visualized perforator vessels and the distal networks were distinguished based on the color gradation. The body surface markings were preserved until the operation day using a film sheet. Two days before the operation, the three-dimensional vascular data were converted into a two-dimensional vascular map using a projective image reconstruction technique. A semi-automated normal vector detection method and curvature approximation were applied to maintain accuracy. The depth was indicated by color gradation on a sterilized transparent sheet. The mapping sheet was attached to the patient’s thigh before the operation. The skin incision was performed with cutting the transparent mapping sheet. The stem portion of the perforator vessels was evaluated at the level of fascia lata.

Results: The first clinical trial involved a 32-year-old male patient with a malignant chest-wall tumor. Each PAT scan took approximately 5 minutes per thigh. The perforator vessels were visualized at the expected points by ultrasonography. A two-dimensional vascular mapping sheet was prepared by drawing the courses of the subcutaneous micro-vessels using projection mapping. Our computing...