LOWER LIMB LYMPHEDEMA TREATED WITH LYMPHATICO-VENOUS ANASTOMOSIS BASED ON PRE- AND INTRAOPERATIVE ICG LYMPHOGRAPHY AND NON-CONTACT VEIN VISUALIZATION: A CASE REPORT

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Lymphatico-venous anastomosis (LVA) is used to resolve lymph retention in lymphedema.1–3 However, the postoperative outcome of lower limb lymphedema is poorer than that for upper limb lymphedema, because of the location lower than the heart level.4,5 Moreover, subcutaneous fat is thick in the lower limb, which may lead to serious symptoms compared to upper limb lymphedema. Therefore, improvement of the therapeutic outcome requires application of as many anastomoses as possible in a limited operation time, particularly since there is a positive correlation between the number of anastomoses and the therapeutic effect of LVA.6

Optimal LVA surgery requires efficient identification of lymph vessels and veins for anastomosis immediately before or during surgery. Identification of lymph vessels can now be achieved with low invasiveness using high-resolution ICG lymphography.7,8 However, there is no equivalent method to identify subcutaneous venules of 0.5–1.0 mm diameter that are suitable for LVA. The minimum size of macroscopically visible subcutaneous veins is about 1 mm, which is larger than the size of lymph vessels to be anastomosed. Moreover, compared with healthy lower limbs, the subcutaneous fat layer is thickened in edematous regions and observation of veins through the skin is difficult. In addition, bilateral lymphedema of the lower extremities is a challenging condition for the microsurgeon since bypassing with the baumeister procedure is not possible.9

In this report, we propose the use of a noncontact-type vein visualization system, AccuVein (Cold Spring Harbor, NY), and ICG lymphography for perioperative identification of lymph vessels and skin venules in treatment of the lower extremity lymphedema with LVA.

CASE REPORT

A 64-year-old Japanese woman had noted worsening edema in her left lower limb for six years. Twelve years ago, she had undergone extended hysterectomy with lymph node dissection for uterine cervical cancer with radiation therapy (50 Gy). An incubation period of lymphedema was six years. Despite constant and strong compressive therapy with an elastic stocking, edema gradually progressed and cellulitis in her right thigh recurred every six months (Fig. 1a).

Since the lesion had gradually enlarged and complicated with cellulitis, the patient consulted our department. She had no family history of lymphedema and had not visited a tropical or subtropical country. This test was approved by our Institutional Review Board and informed consent was obtained from the patient prior to the ICG fluorescent test and AccuVein.

An ICG fluorescent test (Fig. 2a) was performed following reported method by Ogata and Mihara.8

The AV300 system (AccuVein, Cold Spring Harbor, NY) (Fig. 2c) was used to identify subcutaneous venules immediately before and during surgery. In our experience, veins with a minimum diameter of about 0.5 mm are identifiable.
The ICG fluorescent test showed several intact lymph-duct flows in the bilateral dorsum of the feet, in the ankle area, and in the right medial knee. The left thigh and left lower thigh showed severe abnormal images of dermal backflow. Ten LVAs were made at the bilateral medial thigh, left lower abdominal region, right medial knee, bilateral inner ankles, and dorsum of the left foot (Figs. 2b, 2d, 2e) under local anesthesia by three microsurgeons with three surgical microscopes. The operation time was 3 hours and 5 minutes. In the right lower limb, LVA was performed to prevent lymphedema. Compressive therapy was started postoperatively and lymphedema showed mild improvement within 8 months. A physical examination revealed shrinkage of the circumference of the right lower extremity after LVA by 7 cm at the thigh, 6 cm at the knee, 4 cm at the calf, and 3 cm at the ankle compared with the right lower extremity before LVA (Fig. 1b). Cellulitis did not occur after LVA.

**DISCUSSION**

Since symptoms are severe and surgical outcomes tend to be unfavorable in lower limb lymphedema, it is necessary to perform as many successful anastomoses as possible within a limited time in LVA surgery. Because we perform LVA under local anesthesia, operation should be finished before patients complain about their backache. Totally, 4–5 hours is the limitation of this operation. In this report, we showed that a method using a combination of ICG lymphography and AccuVein may be useful for efficient location of lymph vessels and veins that are suitable for LVA.

Identification of lymph vessels can be achieved with ICG lymphography. This method operates in the near-infrared region (780–1,500 nm) and there is no background noise due to autologous fluorescence. In addition, near-infrared radiation is highly penetrable, which enables evaluation of lymph vessels in the superficial layer of subcutaneous tissue of thickness ≤2 cm. ICG can be used without tissue damage and its safety has been confirmed in clinical practice.6,7

In contrast, subcutaneous veins of about 0.5–1.0 mm, which are suitable for LVA, cannot be visualized in many patients with lower limb lymphedema when edema is severe and lymphedema is chronic. The minimum size of macroscopically identifiable veins is about 1 mm, which is larger than that of the lymph vessels to be anastomosed. Echography is very sensitive and theoretically capable of imaging about 0.3-mm blood vessels, but in practice skin surface veins are collapsed or crushed by the weight of the echo probe and it is difficult to find skin veins for LVA.10 Therefore, a noncontact-type device that does not crush blood vessels is needed. Multidetector computer tomography (MDCT) meets this condition and veins with a minimum size of 0.5 mm can be imaged. However, the required use of contrast medium and the invasiveness of exposure are disadvantages, and MDCT is also a large-scale test that is difficult to perform immediately before and during surgery.11
Because of the difficulties with other methods, we chose to use the AccuVein system for vein identification. AccuVein is a new noncontact non-invasive device with no concerns regarding contrast medium and exposure, and measurement can be readily performed immediately before and during surgery. This device uses infrared and laser technology to help locate veins easily, quickly, and safely by displaying their precise positions beneath the skin. It can detect reduced hemoglobin at about 0.7 cm depth from the surface of the skin. No patient contact is required. When positioned about 8–10 cm above the skin, the device detects the difference in hemoglobin concentration between the veins and surrounding tissue, and then instantly displays a map of the veins on the skin. The hand-held device is the size of a cordless telephone receiver and can be fitted with optional accessories for hands-free use. Using this device, we were able to find subcutaneous venules in various regions of the lower limbs, with a resulting high rate of successful LVA. This device has not been used in lympho-surgery before and there are no publications in the literature about using this device in lymphatic surgery. Besides, the combined use of ICG and AccuVein in LVA surgery has not been reported in the literature before. In the case described here, 10 LVAs were succeeded at seven incisions. This is important, since the number of lymphatic anastomoses is positively correlated with improvement of lymphedema.6

We usually do not use patent blue because it is not confirmed in Japanese drug legislation. The most difficult point in LVA procedure is how to determine the place of skin incision. Once skin incision is made in suitable position, lymphatic channel and venule can be found without

Figure 2. (a) Normal lymph flow in the dorsum of the left foot in ICG lymphography. (b) Intraoperative photograph of the dorsum of the left foot. (c) Subcutaneous vein in the dorsum of the left foot identified using the noncontact vein visualization system. (d) The peripheral side of a subcutaneous lymph vessel (0.9 mm diameter) and a vein (1.2 mm diameter) identified before and during surgery were anastomosed using 12-0 nylon thread. (e) Condition after LVA showing eight interrupted sutures using 12-0 nylon thread. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

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patent blue. Surely, patent blue may be a great help to detect lymphatic channels intraoperatively, ICG and AccuVein can solve the most difficult problem in LVA.

Thus, combined use of ICG and AccuVein in LVA surgery for lower limb lymphedema allows lymph vessels and veins to be found within a short time in regions corresponding to the edema condition in individual patients, with no apparent disadvantages compared to other approaches.

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REFERENCES