

SUCCESSFUL TREATMENT OF EARLY-STAGE LOWER EXTREMITY LYMPHEDEMA WITH SIDE-TO-END LYMPHOVENOUS ANASTOMOSIS WITH INDOCYANINE GREEN LYMPHOGRAPHY ASSISTED

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Purpose: This study was to investigate intraoperative assessment of side-to-end lymphovenous anastomosis (LVA) with indocyanine green (ICG) and the correlation between its patency and surgical outcome. **Methods:** LVA was applied to five patients with early-stage lower extremity lymphedema. Side-to-end anastomosis and then end-to-end anastomosis were created as a second alternative. Immediately after the anastomosis, ICG was used to confirm its patency. **Results:** The mean number of anastomoses was 2.0 ± 0.7 , and the types of anastomoses were primarily side-to-end and secondarily end-to-end. The mean reduction rate was $63.8 \pm 20.2\%$ after LVA at 10 ± 6.4 months of follow-up. In all cases, the affected extremities became soft immediately after surgery, and no cellulitis episodes were observed. **Conclusion:** Side-to-end LVA can be an effective treatment for early-stage lower extremity lymphedema. ICG lymphodynamic assessment is useful not only in the preoperative identification of functional lymphatics but also in the intraoperative visualization of new drainage routes in LVA surgery. © 2015 Wiley Periodicals, Inc. *Microsurgery* 36:310–315, 2016.

Lymphedema is a chronic and progressive disease that is induced by impairments of lymphatic transport capacity that result in edema, the accumulation of protein-rich fluid and, in the later stages, inflammation and irreversible changes, such as fibrosis and the proliferation of adipose tissue.¹ The traditional treatment of lymphedema is complex decongestive physiotherapy (CDP), which consists of exercise, wearing a compression garment, skin care, and manual lymph drainage. CDP not only induces circumferential reduction of the affected extremity but may also prevent cellulitis in early-stage lymphedema patients.^{2,3} However, this therapy is primarily aimed at delaying progression and is not curative. Many surgical techniques have been described, including lymphovenous anastomosis (LVA),⁴ lymphovenous–lymphatic (LVL) transplant,⁵ and lymphatic vessel transplantation.⁶ LVA is widely used as a surgical treatment for secondary lymphedema, and in this procedure, the collecting lymphatic

vessels are anastomosed to the subdermal vein under a microscope to create a new diversion channel from the lymphatic system to the venous system in the peripheral region of the affected extremity.^{4,7–12} Several studies have found that LVA is effective in early-stage upper extremity lymphedema but less effective in advanced-stage disease or lower extremity lymphedema^{7,10,13} possibly because the lymphatic vessels lose their abilities to transfer lymph fluid and are degenerated in advanced lymphedema. Furthermore, most of the patent lymphatic vessels that are available for anastomosis are difficult to find among the fibrotic tissues in severely lymphedematous extremities. Additionally, the outcomes achieved for patients who have undergone LVA for lower extremity lymphedema are not as impressive as those for patients who have undergone LVA for upper extremity lymphedema partially because the lower extremities are much larger, and the venous pressure of the lower extremities is higher than that of the upper extremities.¹⁴

Indocyanine green (ICG) is a water-soluble tricarbo-cyanine dye that was first approved for clinical use in humans in 1956.^{15,16} ICG binds to plasma proteins and emits fluorescence that can be detected by fluorescent imaging and enables the evaluation of tissue perfusion, uptake, distribution, and clearance of dye-marked fluid.¹⁷ Following intracutaneous injection, ICG fluorescence can be used to visualize the lymphatic vessels and allow surgeons to locate a functional lymphatic vessel. While multiple studies have shown the clear utility of ICG lymphography in LVA surgery and the diagnosis of the severity of lymphedema,^{18,19} no work has addressed the utility of intraoperative ICG lymphodynamic study to demonstrate the feasibility and efficacy of LVA surgery in lower extremity lymphedema. The purpose of this

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