Lymphaticovenous Bypass: Adaptations and Lessons Learned

Heather L. Baltzer, MD, MSc*  
Sebastian Winocour, MD, MSc†  
Christin Harless, MD†  
Michel Saint-Cyr, MD†

Summary: Advances in microsurgical instruments and techniques have allowed for introduction of lymphaticovenous anastomosis as a potential surgical treatment for patients with upper and lower extremity lymphedema. This article reviews the approach to lymphaticovenous anastomosis patient selection and technical modifications that improve the ease and efficiency of the procedure. (Plast Reconstr Surg Glob Open 2017;5:e1328; doi: 10.1097/GOX.0000000000001328; Published online 7 June 2017.)

INTRODUCTION

Lymphedema remains a poorly understood disease process that develops after a disruption of the microvascular filtration of the lymphatic drainage system after surgery or radiation. Unfortunately, limited treatment options exist and are based primarily on nonsurgical options including massage therapy, compression garments, and weight loss.1 Recent advances in microsurgical instruments and techniques have evolved into a new subspecialty of supermicrosurgery with the introduction of lymphaticovenous anastomosis (LVA),2–5 in which lymphatic channels <800 microns in diameter are anastomosed to local venules, redirecting the accumulated lymph into the venous system. This concept was first described in the 1960s6,7 and has demonstrated success in limb volume reduction, particularly in earlier stage lymphedema (stage 1–2).3,8 There may also be a reduced risk of extremity lymphedema-associated cellulitis.2 In this article, we describe the technical modifications adapted based on our LVA experience. This discussion will focus on the approach to LVA patient selection used at our institution and technical modifications that improve the ease and efficiency of the procedure.

Patient Selection

Patient selection is key to the success of LVA. Patients are selected who have clinical stage 1 or 2 lymphedema using the International Society for Lymphology classification.9 Patients who have been compliant with nonoperative measures and do not demonstrate considerable improvement in symptoms and quality of life should be considered for surgery. Proximal lymphedema can also improve after LVA performed in the distal extremity. If there is little improvement proximally, it is possible to use liposuction as an adjunct.

Once the decision is made to proceed with LVA, patient selection is based on the presence of appropriate lymphatic ducts, which can be mapped either in the clinic or the operating room. Once appropriate lymphatic ducts are identified, a general anesthetic is administered and the LVA procedure is performed. When no appropriate lymphatic ducts are identified, the procedure is aborted. Preoperatively, the patient must be prepared for the risk of terminating the procedure at this juncture. Among patients with stage 1 or 2 lymphedema, we have found that about 10% do not have appropriate lymphatic channels to proceed with an LVA procedure.

Lymphatic mapping is performed with intradermal injection of 0.1–0.2 mL of indocyanine green (ICG) using a 27-g needle on a tuberculin syringe dorsally over each webspace. Mapping on the dorsum of the hand or foot before exploration is preferred: (1) Target vessels (veins and lymphatic ducts) are more abundant distally; (2) there is minimal subcutaneous fat in the hand or foot. Lymphatic ducts are imaged using the fluorescence imagine system (SPY) imaging system or another ICG device a few seconds after ICG injection. Rather than waiting for 5 minutes, we have found visualization of the functional lymphatic ducts in a more reliable way immediately postinjection, and this avoids a haze that obscures visualization.

Selection of appropriate lymphatic ducts is based on (1) the presence of dynamic lymphatic flow and (2) distal–proximal directionality of flow. Dynamic
flow is indicated when channels illuminate immediately with SPY imaging. Milking these vessels should demonstrate dynamic flow (channel emptying and filling) and flow directionality (see video, Supplemental Digital Content 1, which displays an SPY video of lymphatic duct dynamic filling with ICG, http://links.lww.com/PRSGO/A447). If stasis occurs (e.g., no dynamic filling, see video, Supplemental Digital Content 2, which displays an SPY video of dermal stasis with ICG, http://links.lww.com/PRSGO/A448), it is not an adequate duct to use for LVA. The location of appropriate lymphatic channels should guide incision location (see figure, Supplemental Digital Content 3, which displays an incision location relative to lymphatic duct in upper extremity, http://links.lww.com/PRSGO/A449).

After lymphatic mapping, we proceed with intradermal injection of lymphazurin blue (0.1 mL) dorsally at each web space. When there are abundant lymphatic ducts, these can be sometimes grossly visualized (Fig. 1). Throughout the procedure, lymphazurin blue can be re-injected if the tissues in the operative field are not stained. This should be performed approximately 2–3 cm distal to the operative site using 0.1 mL.

LVA Technique

Rather than injection with lidocaine with epinephrine for local hemostasis, we prefer to use a tourniquet device (200 mm Hg) following extremity elevation. We have found that epinephrine injected locally causes vasoconstriction of veins making them more difficult to identify. Using a tourniquet maintains some blood within the venous system while minimizing hemorrhage that can obscure the lymphatics. In our experience, tourniquet use has not lead to any exacerbation of extremity lymphedema.

Under microscope magnification, the skin is incised and flaps are carefully elevated in the subdermal plane. Veins and lymphazurin blue–filled lymphatic ducts are identified (Fig. 2). If multiple lymphatic ducts are identified, multiple individual LVAs are performed within the same incision. Typically 2–3 anastomoses are performed for each region (e.g., hand or forearm). Veins are easily identified within the site of dissection and selected based on appropriate size match. Lymphatic ducts are clipped and transected proximally to give adequate length. The veins are clamped and cut distally (see figure, Supplemental Digital Content 4, which displays a proximally clipped and transected lymphatic ducts to allow adequate length, http://links.lww.com/PRSGO/A450).

The tourniquet is let down after anastomosis to verify dynamic flow and ensure hemostasis. Supercamicrosurgical instruments are necessary for performing the anastomosis. For an end-to-end anastomosis, the 2 vessels are approximated with a double-approximating clamp (BV1) and floated open with heparinized saline. A small piece of 6-0 monofilament suture can be used to stent the lymphatic ducts to prevent back-walling or one arm

Fig. 1. Grossly visualized lymphatic ducts with lymphazurin blue.
of the supermicrosurgery forceps (see figure, Supplemental Digital Content 5, which displays a stenting lymphatic ducts with monofilament suture (A) or one arm of supermicrosurgery forceps (B), http://links.lww.com/PRS/GO/A451). The anastomosis is performed using a shortened 11-0 nylon suture, and typically 4–6 sutures are necessary (Fig. 3). A successful anastomosis is evident by flow of blue-stained lymph into the vein (see figure, Supplemental Digital Content 6, which displays a lymphazurin blue flowing across LVA, http://links.lww.com/PRS/GO/A452).

Size mismatch is often present between the lymph duct and the vein. The vein diameter can be reduced with a microclip or the smaller lymphatic duct can be intussuscepted into the vein. Multiple end-to-side anastomoses can be done into 1 vein (see figure, Supplemental Digital Content 7, which displays end-to-side LVA anastomoses, http://links.lww.com/PRS/GO/A453); however, end-to-end anastomosis is technically less demanding. If there are no lymphatic ducts present within the incision, but there is blue-stained lymphatic tissue with obvious ducts that are too small to perform an anastomosis, the lymphatic tissue with multiple small channels can be intussuscepted into the vein. With any intussusception, typically the channel or the lymph tissue is placed within the venule for approximately 2 mm and secured with two 11-0 sutures. When only lymph tissue is present, it is identified by blue staining, indicating multiple smaller channels and transection of the tissue creates an accumulation of lymphatic fluid.

The tourniquet is inflated for 1-hour intervals, and multiple anastomoses are performed during these intervals. One hour of tourniquet inflation is followed by 15 minutes of deflation. Upon completion of the case, the extremity is wrapped with a compressive wrap with the extremity extended. Postoperatively, the patient refrains from the preoperative lymphedema regimen (e.g., no compression garments) until 4 weeks postoperatively.

CONCLUSIONS
Despite the high incidence of both upper and lower extremity lymphedema, few centers currently offer these novel microsurgical techniques that have shown promise for symptomatic relief in these patients. We hope that by sharing these technical pearls, more microsurgeons will consider adding this procedure to their toolbox and increase access for these patients.

Michel Saint-Cyr, MD
Division of Plastic Surgery
Department of Surgery
Mayo Clinic
200 First Street SW
Rochester
Minnesota 55905
E-mail: msaintcyr@me.com

REFERENCES
1. Szuba A, Achalu R, Rockson SG. Decongestive lymphatic therapy for patients with breast carcinoma-associated lymphedema: A randomized, prospective study of a role for adjunctive intermittent pneumatic compression. Cancer. 2002;95:2260–2267.
2. Campisi C, Davini D, Bellini G, et al. Lymphatic microsurgery for the treatment of lymphedema. Microsurgery. 2006;26:65–69.
3. Koshima I, Inagawa K, Urushibara K, et al. Supermicrosurgical lymphaticovenular anastomosis for the treatment of lymphedema in the upper extremities. J Reconstr Microsurg. 2000;16:437–442.
4. O’Brien BM, Mellow CG, Khazanchi RK, et al. Long-term results after microlymphaticovenous anastomoses for the treatment of obstructive lymphedema. Plast Reconstr Surg. 1990;85:562–572.
5. Suami H, Chang DW. Overview of surgical treatments for breast cancer-related lymphedema. Plast Reconstr Surg. 2010;126:1853–1863.
6. Laine JB, Howard JM. Experimental lymphatico-venous anastomosis. Surg Forum. 1963;14:111–112.
7. Jacobson JH, 2nd, Suarez EL. Microvascular surgery. Dis Chest. 1962;41:220–224.
8. Chang DW, Suami H, Skoracki R. A prospective analysis of 100 consecutive lymphovenous bypass cases for treatment of extremity lymphedema. Plast Reconstr Surg. 2013;132:1305–1314.
9. International Society of Lymphology. The diagnosis and treatment of peripheral lymphedema: consensus document of the International Society of Lymphology. Lymphology. 2003;36:84–91.