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VIEWPOINT
Reconstructive

Eliminating Venous-to-lymphatic Reflux by Converting End-to-side to End-to-end Lymphovenous Bypass With Ligation of the Distal Vein

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Lymphovenous bypass (LVB) has become one of the most common microsurgical options for treating extremity lymphedema.[1] In this procedure, lymphatic ducts are bypassed to adjacent veins to reduce lymph stasis.[2] The selection of the lymphatic vessel, vein, and bypass technique can impact efficacy and functional recovery. A favorable pressure gradient is generated when the pressure gradient at the bypass level allows lymph to move into the recipient vein. It should be avoided when the blood pressure in the recipient vein is equal to or higher than the lymphatic pressure.

There is currently no consensus on which type of anastomotic technique allows for the most favorable lymphovenous pressure gradient. Common configurations include end-to-end, end-to-side, and side-to-end. Side-to-end bypass allows both antegrade and retrograde lymphatic drainage to flow through a single bypass.[3] Venous-to-lymphatic reflux has been reported but can be alleviated by ligating the proximal lymphatic vessel.[4] The debate of end-to-side, end-to-end, or side-to-end is currently unresolved.[5]

In this discussion, we describe our observation in a case of end-to-side LVB in which we performed an end-to-end anastomosis with the lymphatic duct anastomosed to a side branch of the recipient vein.

LVB was performed by the senior author (J.H.D.) using a surgical microscope (Pentero 800, Carl Zeiss AG, Oberkochen, Germany). A large size discrepancy was noted between the lymphatic duct (0.6 mm) and the recipient vein (2 mm), so given the presence of a lateral branch (0.6 mm), this was used for end-to-end anastomosis. We observed active smooth muscle pumping lymph into the vein with intermittent reflux from the main vein into the small vein branch, but not across the anastomosis. This reflex was effectively eliminated and converted to venous washout with ligation of the distal vein (Fig. 1). The distal vein of the LVB was clamped temporarily for at least 15 minutes to ensure the presence of venous washout before permanent ligation. When clamping the distal main vein during end-to-end bypass with the lymphatic anastomosed to the vein side branch, we observed no venous back bleeding running into our lymphovenous anastomosis. Lymphatic flow appeared to increase into the vein both clinically and with indocyanine green lymphography. (**See Video 1 [online]**, which displays the evaluation of the lymph flow into the recipient vein with indocyanine green lymphography.)

A possible physical explanation for the improved lymphatic outflow can lie in the law of fluid dynamics (flow = $\Delta P/R$). The entity of the flow between 2 points is directly proportional to the pressure gradient and inversely proportional to the resistance; this means that, all other conditions being equal, the greater the pressure gradient, the greater the flow will be. By clipping the vein, it is emptied, and therefore, the pressure inside is reduced, increasing the gradient between the lymphatic vessel and the vein itself (Fig. 2).

However, there is the counterargument that the relatively fast venous flow rate compared with lymphatic flow in an end-to-side orientation creates a favorable dynamic for lymphatic fluid to hitchhike into the venous circulation.

The limitation of this observation is that we do not have a quantitative measurement of the flow. Additionally, long-term outcomes of this maneuver are not available. One potential concern and question is whether clipping the distal vein could result in stasis of the blood and formation of a thrombus.

Because venous back bleeding can lead to thrombosis in LVB, in certain circumstances one may consider ligating the distal vein in an end-to-side bypass after observing the flow intraoperatively for at least 15 minutes. Further investigation, preferably both clinical and quantitative, is

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Received for publication October 21, 2024; accepted May 6, 2025.

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Plast Reconstr Surg Glob Open 2025;13:e6929; doi: 10.1097/GOX.0000000000006929; Published online 26 June 2025.

Disclosure statements are at the end of this article, following the correspondence information.

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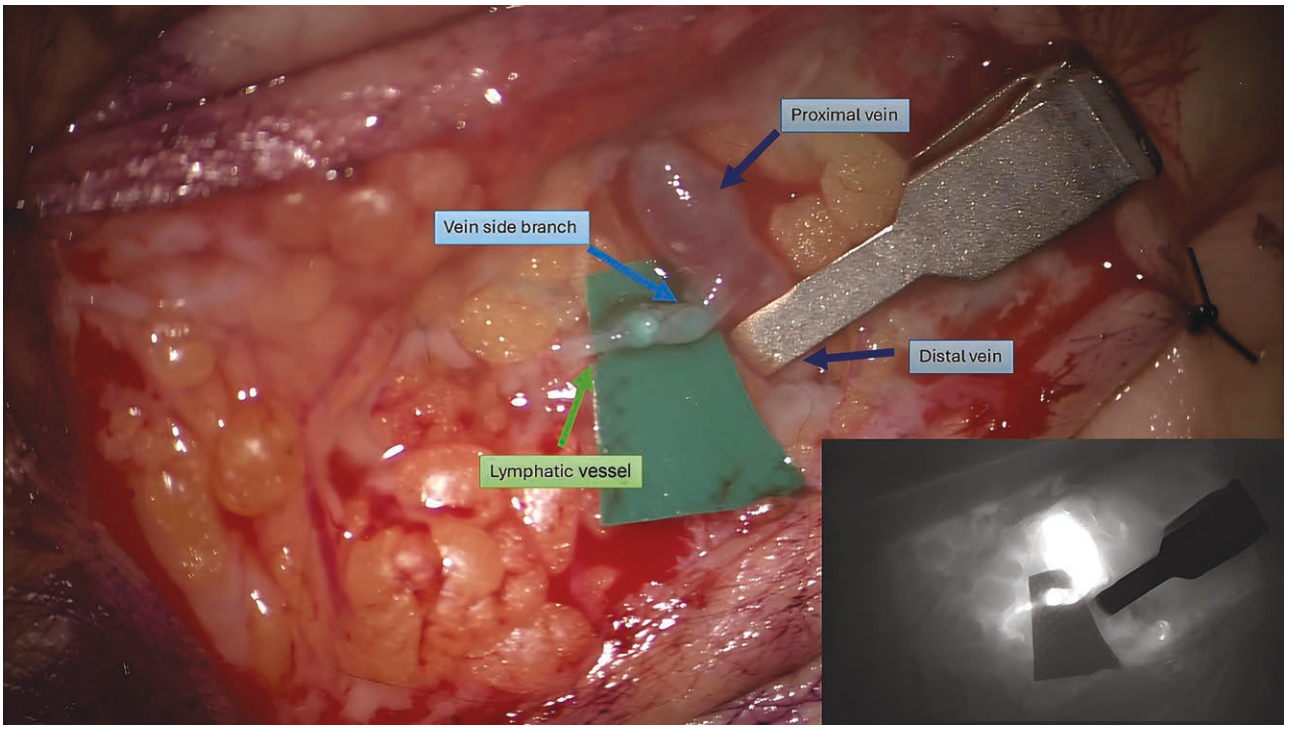

Fig. 1. End-to-end LVB with the lymphatic duct anastomosed to the side branch of the recipient vein. Clipping the distal vein, with higher venous back pressure, resulted in more lymph flowing into the vein and reaching the next valve. This was confirmed with the indocyanine green mode, showing more fluorescence entering into the vein.

needed to determine the ideal LVB orientation for each particular scenario.

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DISCLOSURES

Dr. Dayan is a paid consultant for the Stryker Corporation, is a board member and minor shareholder in Welwaze Medical, LLC, and has a royalty agreement with Springer Publishing for Multimodal Management of Upper and Lower Extremity Lymphedema. The other authors have no financial interest to declare in relation to the content of this article.

REFERENCES

1. Pappalardo M, Chang DW, Masia J, et al. Summary of hands-on supermicrosurgery course and live surgeries at 8th world symposium for lymphedema surgery. *J Surg Oncol.* 2020;121:8–19.
2. Basta MN, Gao LL, Wu LC. Operative treatment of peripheral lymphedema: a systematic meta-analysis of the efficacy and safety of lymphovenous microsurgery and tissue transplantation. *Plast Reconstr Surg.* 2014;133:905–913.
3. Cheng MH, Tee R, Chen C, et al. Simultaneous ipsilateral vascularized lymph node transplantation and contralateral lymphovenous anastomosis in bilateral extremity lymphedema with different severities. *Ann Surg Oncol.* 2020;27:5267–5276.
4. Yang JC, Wu SC, Lin WC, et al. Reversing venous-lymphatic reflux following side-to-end lymphaticovenous anastomosis with ligation of the proximal lymphatic vessel. *J Plast Reconstr Aesthet Surg.* 2021;74:407–447.
5. Bianchi A, Salgarello M, Hayashi A, et al. Recipient venule selection and anastomosis configuration for lymphaticovenular anastomosis in extremity lymphedema: algorithm based on 1,000 lymphaticovenular anastomosis. *J Reconstr Microsurg.* 2022;38:472–480.

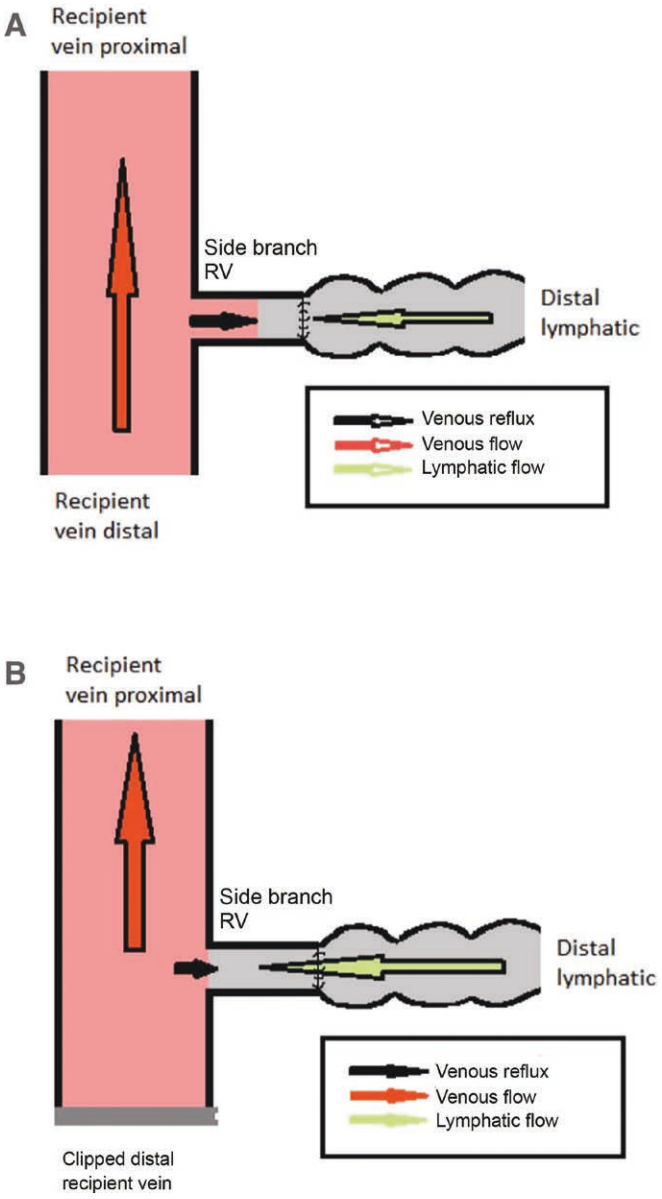

Fig. 2. Venous-lymphatic reflux following end-to-end LVB with the lymphatic duct anastomosed to the side branch of the recipient vein (A). Venous washout after ligation of the distal main vein (B). RV, recipient vein.