Editors' Choice

Evaluation of patency rates of different lymphaticovenous anastomosis techniques and risk factors for obstruction in secondary upper extremity lymphedema

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CME Activity

Purpose or Statement of Need The purpose of this journal-based CME activity is to enhance the vascular specialist's ability to diagnose and care for patients with the entire spectrum of circulatory disease through a comprehensive review of contemporary vascular surgical and endovascular literature.

Learning Objective

- Describe the anastomotic technique that they would use in a patient with lymphedema to maximize patency while reducing the risk of worsening lymphedema if the anastomosis fails

Target Audience This activity is designed for vascular surgeons and individuals in related specialties.

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ABSTRACT

Objective: Lymphaticovenous anastomosis (LVA) is one of the surgical treatments for lymphedema. Lymphaticovenous side-to-end anastomosis (LVSEA) and lymphaticovenous end-to-end anastomosis (LVEEA) are the most commonly used procedures; however, only a few reports have evaluated direct anastomosis. We used indocyanine green fluorescence lymphography to evaluate and to compare both techniques.

Methods: Eighteen patients (67 anastomoses) with secondary upper extremity lymphedema were evaluated 6 months postoperatively. After injection of indocyanine green, anastomoses that were obviously patent were considered patent, and the others were considered unpatent. In addition, we evaluated the risk factors for obstruction using the following five points: dyeing of the lymphatic vessel by patent blue, lymphatic flow, venous regurgitation, lymphatic vessel degeneration, and runoff after the anastomosis.

Results: There were 44 LVSEAs and 23 LVEEAs performed, of which 14 (32%) and 8 (35%) were patent, respectively. Risk factors for obstruction in these 67 anastomoses were evaluated. However, no significant difference was found.

Conclusions: Patency of an LVA anastomosis is not high and not different between LVSEA and LVEEA. However, if anastomotic occlusion occurs, lymphatic obstruction is more likely with LVEEA than with LVSEA. Therefore, when LVA is performed, we recommend LVSEA principally and LVEEA only when the potential for consequences and risk of obstruction are low. (J Vasc Surg: Venous and Lym Dis 2019;7:113-7.)

Keywords: Secondary lymphedema; Upper extremity; Lymphaticovenous anastomosis (LVA); Patency rate

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Lymphaticovenous anastomosis (LVA), one of the treatment modalities for lymphedema, is aimed at symptom relief through creation of an anastomosis between the congested lymphatic vessel, secondary to lymphedema, and a vein. Many consider the impact of the particular LVA technique, in comparison to many other factors, to be a small part of the ultimate functioning or patency of the lymphatic reconstruction. However, LVA reconstructs physiologic lymphatic flow with minimal invasiveness and contributes to improving patients' lives, although it is a sophisticated supermicrosurgery technique because the diameter of the lymphatic vessel is usually smaller than 0.8 mm.[1]

Several techniques have been reported for anastomoses: lymphaticovenous side-to-end anastomosis (LVSEA), lymphaticovenous end-to-end anastomosis (LVEEA), lambda-shaped anastomosis, and others.[2-7] Some reports indirectly evaluated the efficacy of LVA, by volume reduction rate, for example[8,9]; however, only a few evaluated postoperative patency directly. The outcome of the patency rate using indocyanine green (ICG) fluorescence lymphography of LVSEA to evaluate postoperative anastomosis patency has been previously published.[10] Nevertheless, no reports have been published on LVEEA worldwide. In addition, there has been no direct comparison between LVSEA and LVEEA. LVSEA requires a more delicate technique than does LVEEA, but LVSEA can connect vessels of different diameters. LVEEA is advantageous in that it drains all distal lymphatic flow into the vein. Our report compares the patency rates of these two methods and evaluates some of the risk factors for obstruction.

ARTICLE HIGHLIGHTS

- **Type of Research:** Single-center retrospective cohort study
- **Take Home Message:** Six-month patency, determined by indocyanine green fluorescence lymphography, was 32% in 44 side-to-end lymphaticovenous anastomoses and 35% in 23 lymphaticovenous end-to-end anastomoses ($P = .81$) in 18 patients with secondary upper extremity lymphedema. Quality of lymphatic flow, reflux at the anastomotic site, lymphatic vessel degeneration, and runoff did not significantly influence patency.
- **Recommendation:** The authors recommend use of lymphaticovenous side-to-end anastomosis as a primary option. Lymphaticovenous end-to-end anastomosis is recommended only when the risk and potential for consequences of anastomotic occlusion are low.

METHODS

Eighteen patients (23 extremities and 67 anastomoses) who were evaluable for patency by ICG fluorescence lymphography 6 months after LVA operation for secondary upper extremity lymphedema, from August 2013 to November 2016, were chosen. All patients received complex decongestive physiotherapy preoperatively. Patients wore compression sleeves during the day, and lymphatic drainage was performed at night with a wearable low-pressure compression wrap originally made of urethane foam. This conservative therapy was performed for at least 6 months before surgery. Surgery was performed under general anesthesia. During the operation, the lymphatic vessel was identified by injecting patent blue (Wako Junyaku Kogyo Co, Ltd, Osaka, Japan)[11] and was anastomosed using 11-0 or 12-0 nylon. LVSEA and LVEEA were selected subjectively, although we principally performed LVSEAs. LVEEAs were performed only in regions where the influence of flow was low, such as just before dermal backflow (DBF), or where two of the same functioning lymphatic vessels were found near the anastomosis site. Thus, there was a larger number of LVSEAs than LVEEAs. Postoperative evaluation was performed after 6 months. We observed the anastomosis point with PDE-neo (Hamamatsu Photonics, Hamakita, Japan) after injecting ICG into the subcutaneous tissue.

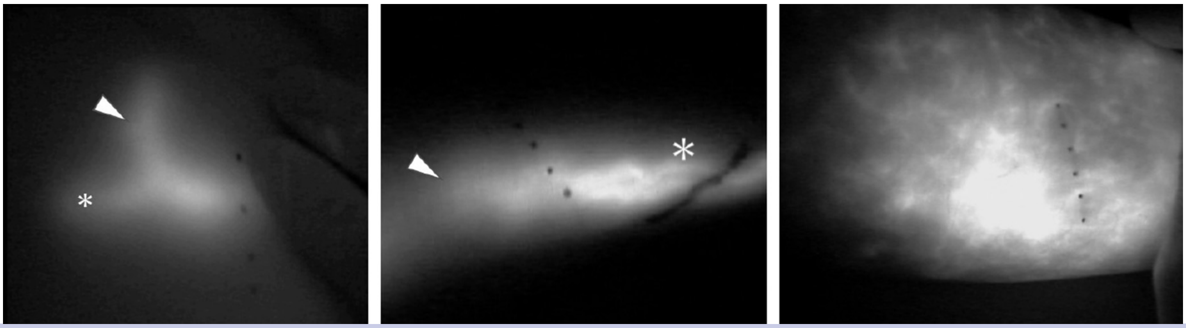

Fig 1. *Left,* Lymphaticovenous side-to-end anastomosis (LVSEA) patency is suggested by the two separate flows. *, Vessel duct; ▽, vein. *Middle,* Indocyanine green (ICG) flow across anastomosis point is shown by a *dotted line,* suggesting lymphaticovenous end-to-end anastomosis (LVEEA) patency. *Right,* Unevaluable because of dermal backflow (DBF). In our study, this was considered unpatent.

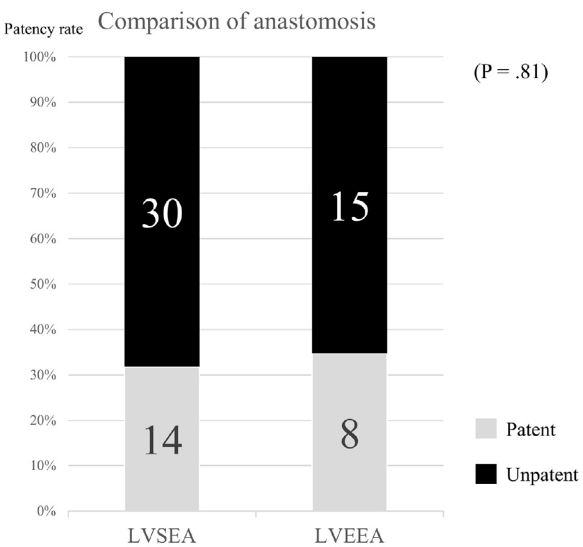

Fig 2. Bar chart comparing anastomoses. *LVEEA,* Lymphaticovenous end-to-end anastomosis; *LVSEA,* lymphaticovenous side-to-end anastomosis.

Obviously patent anastomoses were considered patent, and the others were considered unpatent (Fig 1). In addition, we evaluated the risk factors for obstruction by using the following five points: dyeing of the lymphatic vessel by patent blue, lymphatic flow, venous regurgitation, lymphatic vessel degeneration, and runoff after the anastomosis. Dyeing by patent blue defined deep dyeing as good dyeing (D+) and light blue or no dyeing as poor dyeing (D−). Lymphatic flow was determined by extension of visual observation, patency test, or outflow when the lymphatic vessel was cut or fenestrated to the side wall. We classified good flow (F+) and poor flow (F−) on the basis of this criterion. Venous regurgitation was considered positive (R+) if venous blood regurgitated across the anastomosis after the suture. Lymphatic vessel degeneration was assessed as normal, ectasis, contraction, and sclerosis according to the subjective evaluation of Mihara et al.[12] Runoff after the anastomosis was classified as excellent if the flow was smooth without compression by lymphatic function, good if the inflow to vein was sufficient with mild compression surrounding the tissues, fair if there was flow into the vessel with compression, and poor if poor inflow occurred into the vein even with compression of the surrounding tissue. This evaluation was done by performing a patency test using two forceps just after the anastomosis. Retrospective evaluation was performed by reviewing medical records, intraoperative pictures, and motion videos. The χ^2 test was used to compare the patency rate of each anastomosis. A *P* value <.05 was considered statistically significant.

All study participants provided their written informed consent. The study was approved by our Institutional Review Board.

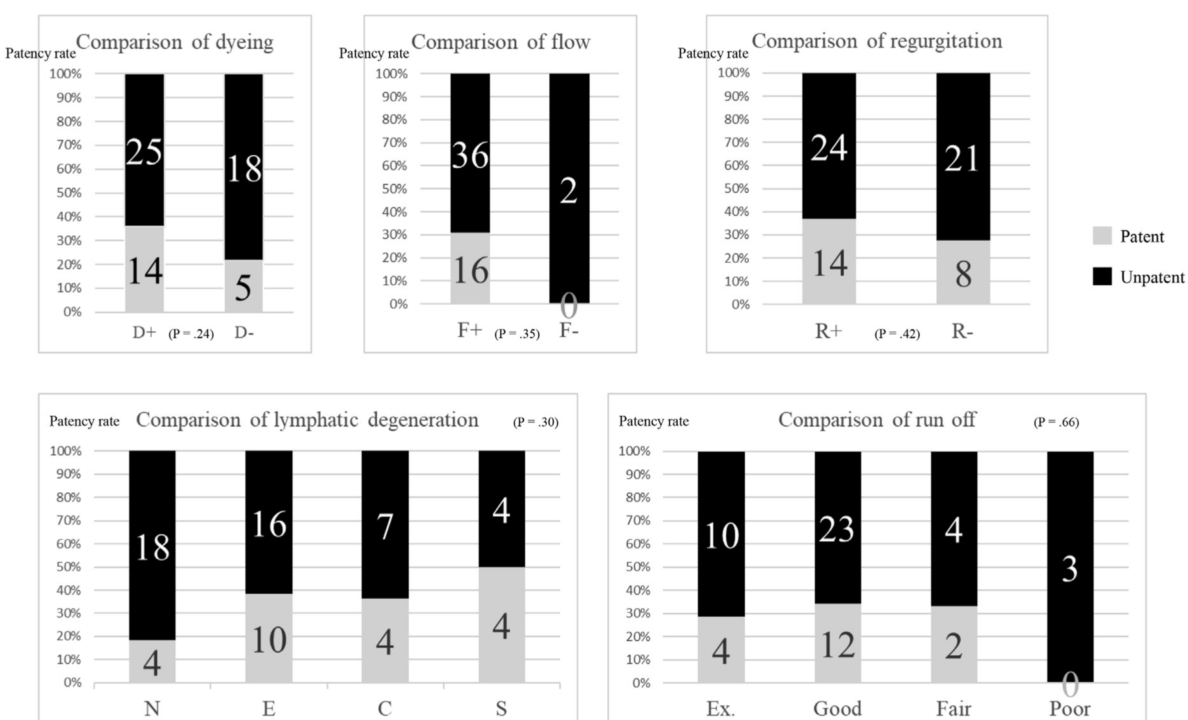

Fig 3. Bar charts showing a comparison between five items that were postulated as risk factors for obstruction. No significant differences were found. *D+,* Good dyeing; *D−,* poor dyeing; *F+,* good flow; *F−,* poor flow; *R+,* regurgitation; *R−,* no regurgitation; *N,* normal; *E,* ectasis; *C,* contraction; *S,* sclerosis.

Fig 4. Schematic showing that lymphaticovenous side-to-end anastomosis (*LVSEA*) remains functional even if obstruction occurs, whereas obstruction worsens lymphedema in lymphaticovenous end-to-end anastomosis (*LVEEA*) by disrupting the distal lymphatic flow.

RESULTS

There were 44 LVSEAs and 23 LVEEAs performed, and patent anastomosis was observed in 14 (32%) and 8 (35%) of them, respectively ($P = .81$; Fig 2). The average diameters of the lymphatic vessel and vein were 0.44 ± 0.13 mm and 0.68 ± 0.23 mm in LVSEA and 0.45 ± 0.10 mm and 0.59 ± 0.19 mm in LVEEA, respectively. Lymphatic dyeing with patent blue was recorded in the medical records for 62 lymphatic vessels. Of 39 vessels with good dyeing, 14 were patent; and of 23 vessels with poor dyeing, five were patent ($P = .24$). In the 54 vessels that could be evaluated for lymphatic flow, 52 showed good flow and 16 were patent; however, no anastomosis was patent in the two vessels with poor flow ($P = .35$). Of 38 regurgitating anastomoses, 14 were patent; and of 29 nonregurgitating anastomoses, eight were patent ($P = .42$). For lymphatic vessel degeneration, 4 of 22 were patent in normal type, 10 of 26 were patent in ectasis type, 4 of 11 were patent in contraction type, and 4 of 8 were patent in sclerosis type ($P = .30$). Excellent runoff was shown in 4 of the 14 patent anastomoses, good in 12 of 35, fair in 2 of 6, and poor in 0 of 3 anastomoses ($P = .66$; Fig 3).

DISCUSSION

Nowadays, surgical treatments such as LVA and lymph node transfer are used for lymphedema treatment in addition to conservative compression therapy.[13,14] LVA reconstructs physiologic lymph flow effectively by connecting the congested lymphatic vessel to a vein and is less invasive surgery because the skin incision measures only 2 to 3 cm. Good results were reported for lymphedema treatment,[8-10,14] but LVA was ineffective for advanced lymphedema and hence offers incomplete treatment. A simple and objective measurement, water volumetry and circumference, is used for postoperative follow-up[4,8,14]; however, this method is easily influenced by alterations in body weight. To overcome this limitation, few researchers consider body mass index revision necessary.[15] Nevertheless, volumetry and circumference are not reflective of the actual surgical result because they are easily influenced by postoperative compression therapy. Lymphoscintigraphy[8,14] is also used to evaluate lymphatic function postoperatively, but evaluation of the local anastomosis site is difficult, especially if many anastomoses were performed in one operation. Previous studies using ICG fluorescence lymphography to evaluate the patency rate of anastomosis are rare; only one report evaluated anastomosis by ICG, and it was limited to LVSEA only.[10] ICG fluorescence lymphography has the advantage of observing the dynamic movement of the collecting lymphatic vessel and lymph flow changes, like DBF, in real time, whereas its limitation is the inability to penetrate deep and thick subcutaneous tissue.[16-18] In our study, it was difficult to observe DBF when it spread rapidly. This may have resulted in incorrectly considering patent anastomoses as being unpatent. However, the upper extremity has thinner subcutaneous adipose tissue compared with the lower extremity; hence, fewer anastomoses were not evaluable because of their depth.

Anastomosis can be performed using various techniques.[2-7] LVEEA has high drainage effectiveness as it allows flow of all distal lymph fluid. However, obstruction might worsen lymphedema by disruption of the distal lymphatic flow (Fig 4). Moreover, this method does not allow salvage of the regurgitated peripheral lymph flow if there is valve insufficiency in the collective lymphatic vessel. In contrast, drainage effectiveness decreases in LVSEA compared with LVEEA if the lymphatic vessel pressure is low and the venous resistance is high, yet LVSEA allows preservation of the existing lymphatic flow even if anastomosis is obstructed (Fig 4). On the basis of our results, no significant difference exists between the methods, and the patency rate in both methods is not high. As mentioned before, it is not possible to accurately evaluate deep lymphatic vessels; hence, the real patency rate might be higher than that reported by us, but the risk of obstruction must be considered.

In light of these facts, we should consider occlusion every time. LVSEA does not inhibit existing lymphatic flow, so LVSEA is beneficial in terms of the risk of obstruction. However, LVEEA drains lymph flow effectively, so if we consider only the treatment of lymphedema, LVEEA may be superior to LVSEA. Therefore, we suggest the following strategy. LVSEA should be performed principally, and LVEEA should be performed only when the risk of obstruction is low, that is, in cases of low lymphatic function in the groin area, and if DBF is imminent. Of note, we performed LVEEA in a case with more than two collective lymphatic vessels and preserved lymphatic function in one visual field.

No previous studies have discussed the risk of obstruction. We found no significant differences between the aforementioned five items in our study. However, there is a tendency for weak-flow collective lymphatic vessels as well as for those with poor runoff not to remain patent. Accordingly, it is postulated that a good result might be expected if a lymphatic vessel with good flow is chosen and if the vessels are sutured appropriately to obtain an excellent runoff. However, factors other than lymphatic function and anastomosis technique, including the condition of the vein and tension of the anastomosis site, affect the postoperative runoff. Future studies with a larger sample size are needed to elucidate these factors. Moreover, even if the anastomosis maintained patency for 6 months postoperatively, obstruction might occur later.[10] Therefore, a long-term follow-up is necessary.

CONCLUSIONS

We found no significant differences between LVSEA and LVEEA, and it was clear that the patency rate of LVA was not high. To obtain good results, and considering the risk of obstruction, LVSEA should be performed in principle, and LVEEA should be performed only when the risk of obstruction is low. Further studies are needed to elucidate factors associated with the risk of obstruction.

AUTHOR CONTRIBUTIONS

Conception and design: YS, HS
Analysis and interpretation: YS, HS
Data collection: YS, HS, SY
Writing the article: YS
Critical revision of the article: YS, HS, SY
Final approval of the article: YS, HS, SY
Statistical analysis: YS
Obtained funding: Not applicable
Overall responsibility: YS

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