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Case Report

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Vascularized lymph node transfer with efferent lymphatico-lymphatic anastomosis for treatment of upper extremity lymphedema

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Abstract

Vascularized lymph node transfers (VLNT) are useful options for the surgical treatment of lymphedema. Conventional VLNT does not include the reconstruction of physiological lymphatic outflow, which may pose a risk of postoperative lymphatic vessel obstruction and lymph node sclerosis. We report a case of lymph flow bypass reconstruction using a superficial circumflex Iliac artery perforator (SCIP) flap, including VLNT with efferent lymphatico-lymphatic anastomosis. A 63-year-old female with severe right upper extremity lymphedema after mastectomy was reconstructed using a SCIP free flap, which included a vascularized lymph node elevated from the left groin area and transferred to the right axilla area. The SCIP vessels were anastomosed to the medial intercostal artery perforator vessels and the efferent lymphatic vessel from the vascularized lymph node was anastomosed to the internal mammary lymphatic vessels using supermicrosurgical technique. Indocyanine green lymphography showed the reconstructed lymphatic flow from the right hand to the right internal mammary lymphatics through the transferred flap. Postoperatively, lymphedema improved and there was no lymphedema at the donor site with a 2-year follow-up. Lymphatic flow bypass reconstruction using VLNT with efferent lymphatico-lymphatic anastomosis may provide a useful option for the treatment of severe lymphedema.

Keywords: Lymph tissue transplantation, upper extremity lymphedema, vascularized lymph node transplantation

INTRODUCTION

The first lymphaticovenular anastomosis (LVA) was reported by Yamada in 1969[1]. However, the practical utilization of LVAs in the treatment of lymphedema remained limited until the development of supermicrosurgical technique that enabled anastomosis of vessels less than 0.5 mm in diameter and the establishment of supermicrosurgical LVA by Koshima in 2000[2]. The surgical treatment for lymphedema has since evolved, with LVA, VLNT, and vascularized lymphatic transplantation (LT) becoming the common methods used for treatment[3-5].

LVA is especially effective for early stages of lymphedema but is less effective for severe cases in which the lymphatics have already become sclerotic[3,6]. In such severe cases of lymphedema, VLNT or LT are often required[4,6]. VLNT was first reported by Chen *et al.* in the canine model in 1990 and has become the major surgical treatment for severe lymphedema of the extremities[7,8]. The outcome of VLNT in extremity lymphedema showed significantly better improvement in the long term compared to LVA, although both procedures were effective in the short term[9]. A recent review reported that mild or moderate lymphedema of extremities who undergo VLNT are more likely to avoid the need for postoperative further conservative therapy, but severe lymphedema extremities still require conservative therapy after VLNT[10]. The concept behind conventional VLNT is that lymphatic fluid is absorbed by the lymph node and then flows out to the recipient vein[7,11]. The disadvantage of this procedure is that there is no effective utilization of the original efferent lymphatic vessel, and this may cause subsequent efferent lymphatic channel obstruction following lymph node sclerosis.

LT was first reported by Koshima in 2016 to transfer vascularized lymphatic vessels to treat lymphedema in tissues with irreversible lymphatic smooth muscle cell degeneration[3]. However, this method also does not include anastomosis of lymphatic vessels.

In order to reconstruct the physiological and natural lymphatic flow, reconstruction of lymphatic bypass from the affected areas to intact lymphatics using transplanted vascularized lymphatic tissue with the restoration of efferent lymphatic flow is ideal. In this case report, we present the first case of reconstruction of lymphatic flow using vascularized lymph nodes and lymphatics with efferent channel anastomosis in a patient with upper extremity lymphedema.

CASE REPORT

A 63-year-old female presented with a history of progressively worsening right upper extremity lymphedema. Fourteen years ago, she underwent a right partial mastectomy and axillary lymph node dissection for right breast cancer. A diagnosis of secondary lymphedema was made at her local hospital 11 years postoperatively, and conservative therapy using the compression sleeves commenced following this diagnosis. Although she continued to apply this therapy for 2 years, the right upper extremity lymphedema had worsened. She was referred to our department for surgical consideration 13 years postoperatively.

On arrival, a physical examination revealed that her right upper extremity lymphedema (UEL) was classified stage II according to the International Society of Lymphology (ISL) classification. The UEL index of her right extremity was 141 and classified as stage II according to the UEL stage[12]. The UEL index was calculated as described by Yamamoto *et al.* by a summation of squares of limb circumferences (cm) at five points (the elbow, five cm above and below the elbow, the wrist, and the dorsum of the hand) divided by body mass index[12]. The UEL stage is as follows: < 130 corresponded to UEL stage I, 130 to 150 corresponded to UEL stage II, 150 to 170 corresponded to UEL stage III, and < 170 corresponded to UEL stage IV. Preoperative indocyanine green (ICG) lymphography showed dermal backflow of stardust pattern from the hand to the axilla. We performed LVA at two locations on the affected limb, one on the ulnar side of the forearm and one on the medial side of the upper arm. Both were performed with end-to-end anastomosis. Intraoperatively, her lymphatic vessels were found to be severely sclerotic, with no lymphatic flow observed. Although the previous lymphatic vessels were found to be patent, there was no identifiable flow through these anastomoses upon exploration. No significant improvement in UEL was observed after the LVA on 18 months follow-up [Figure 1], and the decision was made to perform free flap transplantation with VLNT and additional efferent lymphatic vessel anastomosis.

Surgical technique

Preoperative ICG lower limb lymphography was performed and the limb lymphatic vessel flow and the location of the groin lymphatic nodes marked [Figure 2]. Surgery was performed under general anesthesia, with the left groin area used as the VLNT donor site. A skin incision was made along the inguinal ligament, and the superficial circumflex iliac artery (SCIA) and vein (SCIV) were dissected. A single lymph node supplied by the proximal SCIA was identified. The feeding artery and vein to the lymph node were confirmed and preserved using a microscope. Both vessels were less than 0.5 mm in diameter. The efferent lymphatic vessel from the node was detected and marked with a vessel clip. ICG and patent blue were then injected into the lateral abdominal region around the posterior superior iliac spine, and the peripheral lymphatic vessels running towards the inguinal lymph node were detected and marked with vessel clips [Figure 2]. A 25 cm × 4 cm fasciocutaneous SCIP flap, including the efferent lymphatic vessel, the lymph node, and the peripheral afferent lymphatic vessels, was designed and harvested based on the superficial branch of the SCIA as a perforator flap [Figure 3]. The efferent lymphatic from the lymph node was transected at the point of the deep fascia. At least two superficial inguinal lymph nodes were preserved to avoid postoperative lymphedema at the donor site. The flap was transferred to the right thoracic region. The distal end of the flap was inserted in the axilla region and the proximal end inserted in the internal mammary region [Figure 3]. A medial intercostal artery perforator (ICAP) arising from the internal mammary artery in the 2nd intercostal space was prepared as a recipient vessel without any resection of costal cartilage. The ICAP artery (0.8 mm diameter) and accompanying vein (2.0 mm) were anastomosed to the SCIA (0.7 mm) and SCIV (1.5 mm), respectively, in an end-to-end fashion using 10-0 nylon.

To reconstruct physiological lymph flow, the efferent lymphatic vessel of the VLNT SCIP flap was preserved. ICG was injected above the 6th rib and an internal mammary collecting lymphatic vessel (0.4 mm) was detected running adjacent to the internal mammary artery [Figure 4]. This was anastomosed to the efferent lymphatic vessel (0.5 mm) of the lymph node in the flap using the intravascular stent (IVaS) technique in an end-to-side fashion using 11-0 nylon[13] [Figure 4].

The proximal skin of the flap was deepithelialized and adipose tissue including the lymphatic vessels was set under the right breast region and used for augmentation of the breast, leaving a 2 cm × 1 cm distal skin island to be used for flap monitoring.

Postoperative care

Postoperative recovery was uneventful, the wounds healed well, and compression dressing was restarted at two weeks. Postoperatively, her right arm UEL index gradually reduced [Table 1]. On review at 24 months postoperative, the UEL index of the affected upper extremity was improved to 134 from 141. Postoperative ICG lymphography showed lymphatic flow from the right extremity to the distal portion of the transferred flap and through the transferred flap to the right internal mammary region [Figure 5]. This indicated the flow of lymphatic fluid from the upper extremity draining into the internal mammary lymphatic system through this flap. The flap donor site healed well with no morbidity and no lower limb lymphedema. No episodes of cellulitis of the affected right upper limb were reported following flap transfer and the patient was extremely satisfied with the result. The total follow-up duration was 2 years.

Table 1. The size of upper extremities and the UEL index

	Preope	1 month	6 months	18 months	24 months
Right (affected side)					
above 5 cm	28	28	29	30	29
elbow	26	27.5	27	28.2	27.5
below 5 cm	25	25	26.5	26.5	27
wrist	18	18	18	18	17
the dorsum of the hand	22	21	21	21	22.5
UEL index	141.1219512	138.2193396	139.3233945	135.7291845	133.9699571
Left (unaffected side)					
above 5 cm	26	26.5	26.5	29	28.5
elbow	24	24	25	25.6	25.5
below 5 cm	23	21.5	24	23.5	22.5
wrist	17	16.5	17	17.5	17
the dorsum of the hand	20	20	20.5	19.5	20
UEL index	112.2727273	114.8928571	118.75	117.3866953	114.0665236
BMI	20.5	21.2	21.8	23.3	23.3

UEL index was calculated by a summation of squares of limb circumferences (cm) at five points (the elbow, five cm above and below the elbow, the wrist, and the dorsum of the hand) divided by body mass index. Postoperative UEL index was gradually improved. UEL: upper extremity lymphedema.

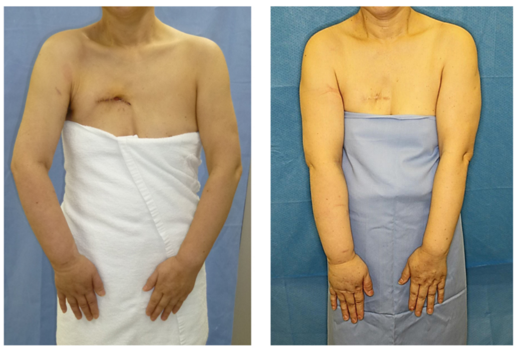

Figure 1. Preoperative and postoperative lymphedema of the upper extremity. Postoperative recovery was uneventful. On review at 18 months postoperative, her right arm UEL index reduced by 5 from 141 before surgery to 136 after surgery. UEL: upper extremity lymphedema.

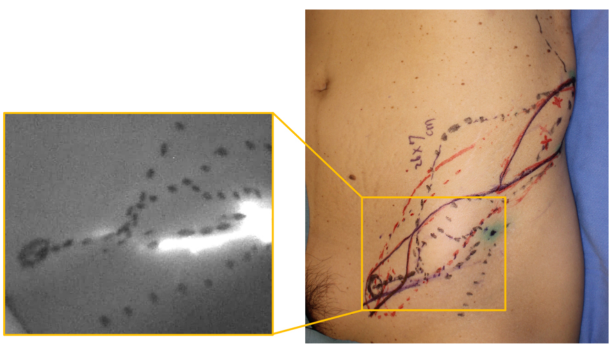

Figure 2. Lymphatic flow in the flap detected by ICG lymphography. ICG lymphography showed the flow of lymphatic vessel and the location of lymphatic node at the donor site. A single lymph node supplied by the proximal SCIA was identified. ICG: indocyanine green; SCIA: superficial circumflex iliac artery.

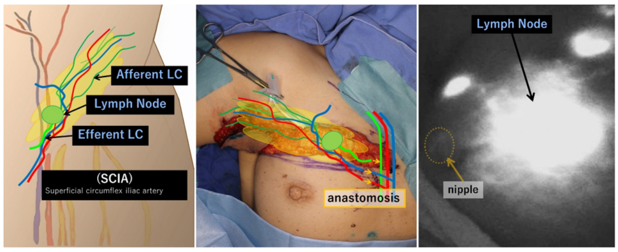

Figure 3. The elevation of the SCIP flap and the transplantation to the breast region. A 25 cm × 4 cm fasciocutaneous SCIP flap including the efferent LC, the lymph node, and the peripheral afferent LC was elevated. The efferent LC in this flap was anastomosed to an internal mammary collecting lymphatic vessel. Postoperatively, ICG lymphography showed a lymph node of the transferred flap. ICG: indocyanine green; LC: lymphatic channel; SCIP: superficial circumflex iliac artery perforator.

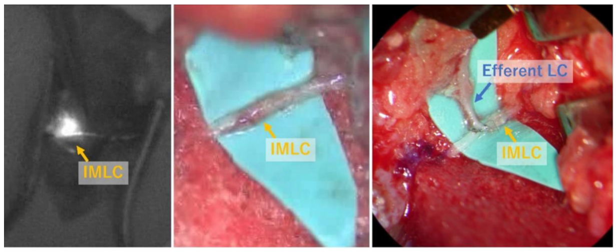

Figure 4. Lymphatico-lymphatic anastomosis. The IMLC was detected by ICG lymphography and microscope. Lymphatico-lymphatic anastomosis was performed between the efferent LC and the IMLC. IMLC: internal mammary lymphatic channel; ICG: indocyanine green; LC: lymphatic channel.

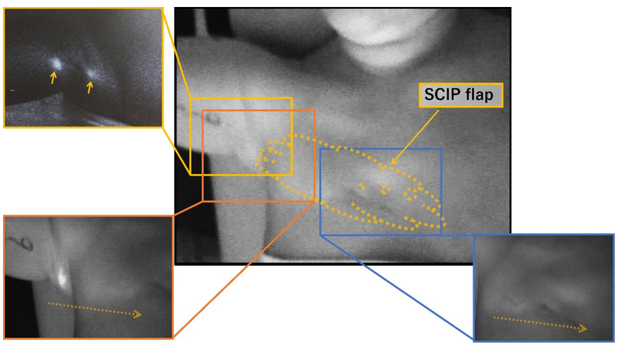

Figure 5. The lymphatic flow through the flap. Postoperative ICG lymphography showed lymphatic flow from the right extremity to the distal portion of the VLNT flap. Lymphatic flow was detected through the transferred SCIP flap to the right internal mammary region. ICG: indocyanine green; VLNT: vascularized lymph node transfers; SCIP: superficial circumflex iliac artery perforator.

DISCUSSION

This case report demonstrates the innovative reconstruction of lymph flow using a VLNT combined with efferent lymphatico-lymphatic anastomosis to treat severe secondary lymphedema of the upper extremity.

Lymphedema occurs in about 20% of patients after lymphatic resection or radiation therapy for breast cancer treatment[14]. According to the experiments of lymph node transfer reported by Chen *et al.*, interruption of physiologic lymphatic flow in the pelvic region does not result in lower limb lymphedema as the lymph fluid in the lower extremities is drained by the inguinal lymph nodes through lymph-venous shunts[7]. This forms the basic mechanism of conventional VLNT in lymphedema treatment; the congestive lymphatic fluid is drained to the transferred lymph nodes and then flows out to drainage veins via lymph-venous shunts inside the lymph nodes[7,11]. However, there is the possibility of the sclerosis of lymph nodes following conventional VLNT due to efferent lymphatic vessel obstruction[15]. In addition, in our experiences, the conventional VLNT is not often effective enough to improve the severe lymphedema extremities, which leads to the need for and idea of lymphatico-lymphatic anastomosis. One of the major limitations of conventional VLNT is the ineffective utilization of the original efferent lymphatic vessels, which may cause efferent lymphatic channel obstruction and lymph node sclerosis postoperatively. Efferent lymphatic occlusion leads to sclerosis of lymph nodes and finally results in lymph node dysfunction[16]. Therefore, we considered that long-term improvement of lymphedema requires the reconstruction of physiological lymphatic flow and sufficient vascularization. In this case, we established a new drainage pathway not only to the veins but also to the lymphatics, which is more natural and physiological compared to conventional LT.

The lymphatic system has a superficial network above the deep fascia and a deep system below the deep fascia[17,18]. Connections between the superficial and deep lymphatic systems are considered to be few, and therefore, the deep system is less influenced by the condition of the superficial system[19,20]. There are no previous reports of reconstructing new drainage routes between the superficial system and the deep system. Our method established a new lymphatic drainage bypass to the internal mammary lymphatics, a part of the deep lymphatic system, which may have, in turn, contributed to obtaining effective lymphatic flow.

The transplanted lymphatics in this report provided active transportation of lymphatic fluid, as confirmed by ICG lymphography. When lymphatics are non-vascularized, the lymphatic vessels can only work as a simple conduit and do not have the ability to actively transport lymphatic fluid[16]. The adipose tissue surrounding transferred lymphatics helps maintain sufficient vascularization, which could have a positive effect on smooth muscle cells, and VLNT develops the potential of rich lymphatic discharge, which may help facilitate lymphangiogenesis[21-23]. In the congestive lymphatics of edematous extremities, smooth muscle cells degenerate, which causes the loss of lymphatic dynamic function[3,24]. Therefore, abundant vascularity contributes to functional lymphatics, which may, in turn, enhance lymphangiogenesis in surrounding soft tissue.

Our method has several disadvantages. Firstly, our method requires supermicrosurgical technique for dissection and anastomosis. In this case, the elevation of the superficial branch-based SCIP flap, internal mammary vessel perforator-to-perforator anastomosis, and most notably, the efferent lymphatico-lymphatic anastomosis which included lymphatic vessels less than 0.5 mm required supermicrosurgical technique. The use of IVaS technique enabled us to perform safe and precise end-to-side supermicrosurgical anastomosis[13]. During such challenging anastomosis involving small vessels where insertion of forceps into the vessel lumen may not be possible, IVaS stents allow traction and distinction of the vessel lumen, thereby preventing inadvertent catching of the back wall and ensuring patency of the anastomosis. Secondly, there is a possibility that the recipient lymphatic vessel cannot be found appropriately. In such a case, lymphatico-venous anastomosis would be one of the options, which cannot be the reconstruction of physiological lymphatic flow but can provide lymphatic flow postoperatively[10,15]. Thirdly, the inclusion of an inguinal lymph node in our flap raises the possibility of postoperative lymphedema at the donor site. To address this, we used intraoperative ICG lymphography, patent blue navigation, and supermicrosurgical technique to resect only one lymph node and preserve other lymph nodes. This cautious approach may have contributed to preventing postoperative donor site lymphedema in our patient.

In conclusion, this is the first report of lymphatic flow reconstruction using free SCIP vascularized lymphatic and vascularized lymph node flap with efferent lymphatic to lymphatic anastomosis. This method has the potential to become one option for improving extremity lymphedema treatment. Further studies are needed to establish the optimal clinical application and effectiveness of this method.

DECLARATIONS

Authors' contributions

Conceptualization: Narushima M
Investigation, writing, original draft preparation: Hosomi K
Writing, review and editing: Banda CH
Data curation, review: Shiraishi M, Mitsui K, Ishiura R, Danno K

Availability of data and materials

Not applicable.

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Conflicts of interest

All authors declared that there are no conflicts of interest.

Ethical approval and consent to participate

The institutional ethics committee of The University of Tokyo Hospital approved the study (approval number: #1616) and consent to participate was obtained from patient.

Consent for publication

Written informed consent was obtained from patient.

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REFERENCES

1. Yamada Y. The studies on lymphatic venous anastomosis in lymphedema. *Nagoya J Med Sci* 1969;32:1-21. DOI
2. Koshima I, Inagawa K, Urushibara K, Moriguchi T. Supermicrosurgical lymphaticovenular anastomosis for the treatment of lymphedema in the upper extremities. *J Reconstr Microsurg* 2000;16:437-42. DOI PubMed
3. Koshima I, Narushima M, Mihara M, et al. Lymphadiposal flaps and lymphaticovenular anastomoses for severe leg edema: functional reconstruction for lymph drainage system. *J Reconstr Microsurg* 2016;32:50-5. DOI
4. Gould DJ, Mehrara BJ, Neligan P, Cheng MH, Patel KM. Lymph node transplantation for the treatment of lymphedema. *J Surg Oncol* 2018;118:736-42. DOI PubMed
5. Schaverien MV, Coroneos CJ. Surgical treatment of lymphedema. *Plast Reconstr Surg* 2019;144:738-58. DOI PubMed
6. Akita S, Mitsukawa N, Kuriyama M, et al. Comparison of vascularized supraclavicular lymph node transfer and lymphaticovenular anastomosis for advanced stage lower extremity lymphedema. *Ann Plast Surg* 2015;74:573-9. DOI
7. Chen HC, O'Brien BM, Rogers IW, Pribaz JJ, Eaton CJ. Lymph node transfer for the treatment of obstructive lymphoedema in the canine model. *Br J Plast Surg* 1990;43:578-86. DOI PubMed
8. Tourani SS, Taylor GI, Ashton MW. Vascularized lymph node transfer: a review of the current evidence. *Plast Reconstr Surg* 2016;137:985-93. DOI PubMed
9. 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;133:905-13. DOI PubMed
10. de Sire A, Losco L, Lippi L, et al. Surgical treatment and rehabilitation strategies for upper and lower extremity lymphedema: a comprehensive review. *Medicina* 2022;58:954. DOI PubMed PMC
11. Cheng MH, Huang JJ, Wu CW, et al. The mechanism of vascularized lymph node transfer for lymphedema: natural lymphaticovenous drainage. *Plast Reconstr Surg* 2014;133:192e-8e. DOI

12. Yamamoto T, Yamamoto N, Hara H, Mihara M, Narushima M, Koshima I. Upper extremity lymphedema index: a simple method for severity evaluation of upper extremity lymphedema. *Ann Plast Surg* 2013;70:47-9. DOI PubMed
13. Narushima M, Koshima I, Mihara M, Uchida G, Gonda K. Intravascular stenting (IVaS) for safe and precise supermicrosurgery. *Ann Plast Surg* 2008;60:41-4. DOI PubMed
14. DiSipio T, Rye S, Newman B, Hayes S. Incidence of unilateral arm lymphoedema after breast cancer: a systematic review and meta-analysis. *Lancet Oncol* 2013;14:500-15. DOI PubMed
15. Akita S, Yamaji Y, Tokumoto H, et al. Improvement of the efficacy of vascularized lymph node transfer for lower-extremity lymphedema via a prefabricated lympho-venous shunt through lymphaticovenular anastomosis between the efferent lymphatic vessel and small vein in the elevated vascularized lymph node. *Microsurg* 2018;38:270-7. DOI PubMed
16. Cook KH, Park MC, Lee IJ, Lim SY, Jung YS. Vascularized free lymph node flap transfer in advanced lymphedema patient after axillary lymph node dissection. *J Breast Cancer* 2016;19:92-5. DOI PubMed PMC
17. Yamamoto T, Yamamoto N, Hayashi A, Koshima I. Supermicrosurgical deep lymphatic vessel-to-venous anastomosis for a breast cancer-related arm lymphedema with severe sclerosis of superficial lymphatic vessels. *Microsurg* 2017;37:156-9. DOI PubMed
18. Shinaoka A, Koshimune S, Suami H, et al. Lower-limb lymphatic drainage pathways and lymph nodes: a CT lymphangiography cadaver study. *Radiology* 2020;294:223-9. DOI
19. Suami H, Taylor GI, Pan WR. The lymphatic territories of the upper limb: anatomical study and clinical implications. *Plast Reconstr Surg* 2007;119:1813-22. DOI PubMed
20. Abdelfattah U, Jaimez PM, Clavero JA, Bellantonio V, Pons G, Masia J. Correlation between superficial and deep lymphatic systems using magnetic resonance lymphangiography in breast cancer-related lymphedema: clinical implications. *J Plast Reconstr Aesthet Surg* 2020;73:1018-24. DOI PubMed
21. Baumeister RG, Siuda S. Treatment of lymphedemas by microsurgical lymphatic grafting: what is proved? *Plast Reconstr Surg* 1990;85:64-74; discussion 75-6. DOI PubMed
22. Suami H, Scaglioni MF, Dixon KA, Tailor RC. Interaction between vascularized lymph node transfer and recipient lymphatics after lymph node dissection-a pilot study in a canine model. *J Surg Res* 2016;204:418-27. DOI PubMed PMC
23. Najjar M, Lopez MM Jr, Ballestin A, et al. Reestablishment of lymphatic drainage after vascularized lymph node transfer in a rat model. *Plast Reconstr Surg* 2018;142:503e-8e. DOI
24. Baik JE, Park HJ, Kataru RP, et al. TGF-β1 mediates pathologic changes of secondary lymphedema by promoting fibrosis and inflammation. *Clin Transl Med* 2022;12:e758. DOI PubMed PMC