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The"Overlapping"Lymphaticovenous Anastomosis: an overlapped end-to-end anastomosis supermicrosurgical technique

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Abstract

Objective Lymphaticovenular anastomosis (LVA) is increasingly utilized in the treatment of lymphedema. This study aims to assess the efficacy and safety of the "Overlapping" LVA technique, which addresses the size mismatch between lymphatic and venous vessels in lymphedema treatment.

Methods Between August 2022 and April 2023, seventeen patients diagnosed with lymphedema were enrolled in this study. The severity of lymphedema in these patients was classified according to the International Society of Lymphology (ISL) staging system.All patient underwent LVA procedures, anastomosis techniques including the Overlapping, end-to-end and octopus anastomosis. The techniques of anastomosis, anastomosis time, patency rate, and volume of limb lymphedema were evaluated.

Results Our study enrolled 17 lymphedema patients who underwent the LVA procedure. All patients showed significant postoperative improvement in limb edema. The mean drainage volume was 472.29 ml. The Overlapping technique demonstrated a 100% success rate as assessed by clinical observation and intraoperative Indocyanine Green (ICG) lymphography. The average anastomosis time was 5.3 min, reducing operative time compared to traditional methods.

Conclusions These findings suggest that the Overlapping technique could serve as a valuable addition to the current LVA technique. This Overlapping anastomosis technique provides a wide range of applications for lymphatic anastomosis treatment and prevention of lymphedema.

Keywords Lymphedema, Anastomosis technique, Lymphaticovenular anastomosis

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Introduction

Lymphaticovenous anastomosis (LVA) treatment for lymphedema has gained significant traction in recent years due to its efficacy in reducing symptoms and improving patient quality of life [1, 2]. Around 120 million people worldwide suffer from lymphedema, which causes severe physical discomfort and reduces the quality of life [3, 4]. LVA surgery utilizes super-microsurgical techniques to establish connections between superficial lymphatic vessels and nearby small veins. This surgery aims to drainage lymph by lymph flow into the venous systemic circulation, thereby alleviating the symptoms of lymphedema by facilitating the return of lymph fluid [5, 6].

Despite the increasing number of research findings on the use of LVA for the treatment of lymphedema [7–10], there is still a lack of surgical techniques for LVA anastomosis in lymphedema complex surgical scenarios. Currently, the primary techniques include end-to-end anastomosis, octopus anastomosis, and end-to-side anastomosis. In LVA surgery, it is very necessary to apply a variety of anastomotic techniques, each technique has its unique advantages and application scenarios, the key point is the effective connection and long-term patency of lymphatic vessels and veins.Nevertheless, The most lymphatic surgeons face a wide range of challenges, it is sometimes difficult to find venules located near an ideal lymphatic vessel with a similar diameter to that of the lymphatic vessel. Therefore, in order to deal with the complex scenarios that may arise during LVA surgery, it is particularly important to develop and optimize the optimal anastomosis techniques. Aims to ensure lymphatic drainage patency and reduce swelling in patients with lymphatic system disorders during LVA surgery.

In this study, we introduce an innovative and simple 'Overlapping' LVA technique. This study aims to demonstrate that the Overlapping Lymphaticovenous Anastomosis technique can effectively connect the lymphatic and venous, thereby expanding the repertoire of anastomosis techniques applicable in complex intraoperative scenarios, and could serve as a valuable addition to the current LVA technique.

Patients and methods

Between August 2022 and April 2023, a total of 17 patients underwent LVA surgeries at Taizhou Hospital of Zhejiang Province affiliated to Wenzhou Medical University. All by surgeons with more than 15 years of experience in microsurgery. The seventeen patients were underwent the LVA procedure, fourteen of whom were postoperative for cervical cancer and three for postoperative breast cancer. The International Society of Lymphology (ISL) staging system was used to classify the severity of lymphedema in these patients. Written informed consent was obtained from all patients for the intraoperative anastomoses involved were end-to-end, octopus and Overlapping anastomosis.

Surgical technique

Preoperative identification of the lymphatic vessels was achieved using Indocyanine Green (ICG 2.5 mg/ml) fluoroscopy for enhanced intraoperative visualization. High-frequency ultrasound was employed to standardize the localization of lymphatics and corresponding veins, with these findings subsequently confirmed via ICG dye-based lymphangiography just prior to surgery. A collaborative clinical judgment was then made to determine the optimal sites for LVAs, which were performed through short incisions approximately 2–3 cm in length. Following the skin incision, meticulous dissection was executed to identify the small subdermal veins and the collecting lymphatic vessels, utilizing 20× to 40× high-power magnification (Zeiss T700; Oberkochen, Germany). In preparation for a tension-free anastomosis, the lymphatic vessels and the vein was carefully dissected, aligned over a surgical background, and assessed for size compatibility to evaluate the feasibility of the LVA technique. Both the lymphatic vessels and the vein were thoroughly prepared to facilitate a tension-free anastomosis.

The Overlapping anastomosis technique, prepare two 11−0 nylon sutures, Step 1: the first suture is placed by inserting needle from the vein outer wall into the lumen and then exiting (Fig. 1, A1), followed from inserting needle within the lymphatic vessel lumen to its outer wall (Fig. 1, A2; Fig. 2, A), and then returning to the vein, inserting from the lumen to exiting the needle through the outer wall (Fig. 1, B1; Fig. 2, B). Step 2: The second suture is done in the same way. (Fig. 1, A1, A2, B1). Step 3: The main surgeon and the assistant traction of two sutures to overlapping the lymphatic vessels overlap the venous vessels (Fig. 1, B2; Fig. 2, C). Step 4: The two sutures are then tied and fixed by passing through the outer membrane of the vein and lymphatic vessel (Fig. 1,C1-C3; Fig. 2D). Next, the microscope was used to check if the indocyanine green fluorescence moved from the lymphatic duct to the subdermal vein in order to confirm anastomotic patency. Immediately after the anastomosis was completed. Observations indicated smooth drainage in the lymphatic vessels with no signs of leakage detected. The anastomosis was completed (Fig. 2E, F; Supplemental Digital Content 1).

The patients underwent an evaluation after the surgery, including compression therapy with pressure and manual lymphatic drainage (MLD). Compression therapy pressure is maintained at 30 ~ 40 mmHg and the MLD involves light hands-on therapy to drain the lymph. Written informed consent was obtained from all patients for preoperative and postoperative photography. The

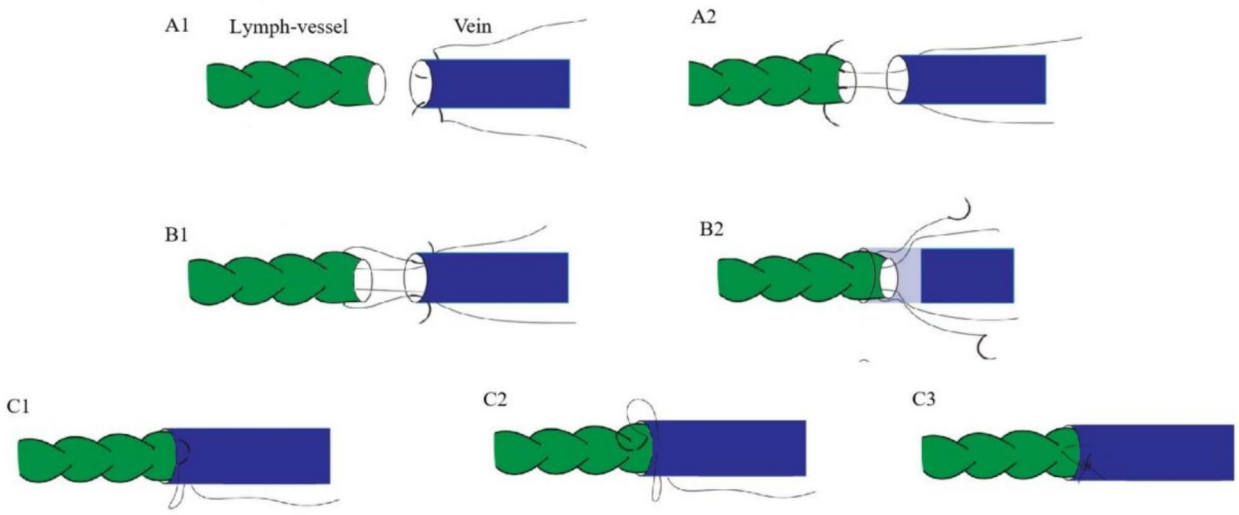

Fig. 1 A diagrammatic representation of the steps involved in carrying out the "Overlapping " (**A-C**)

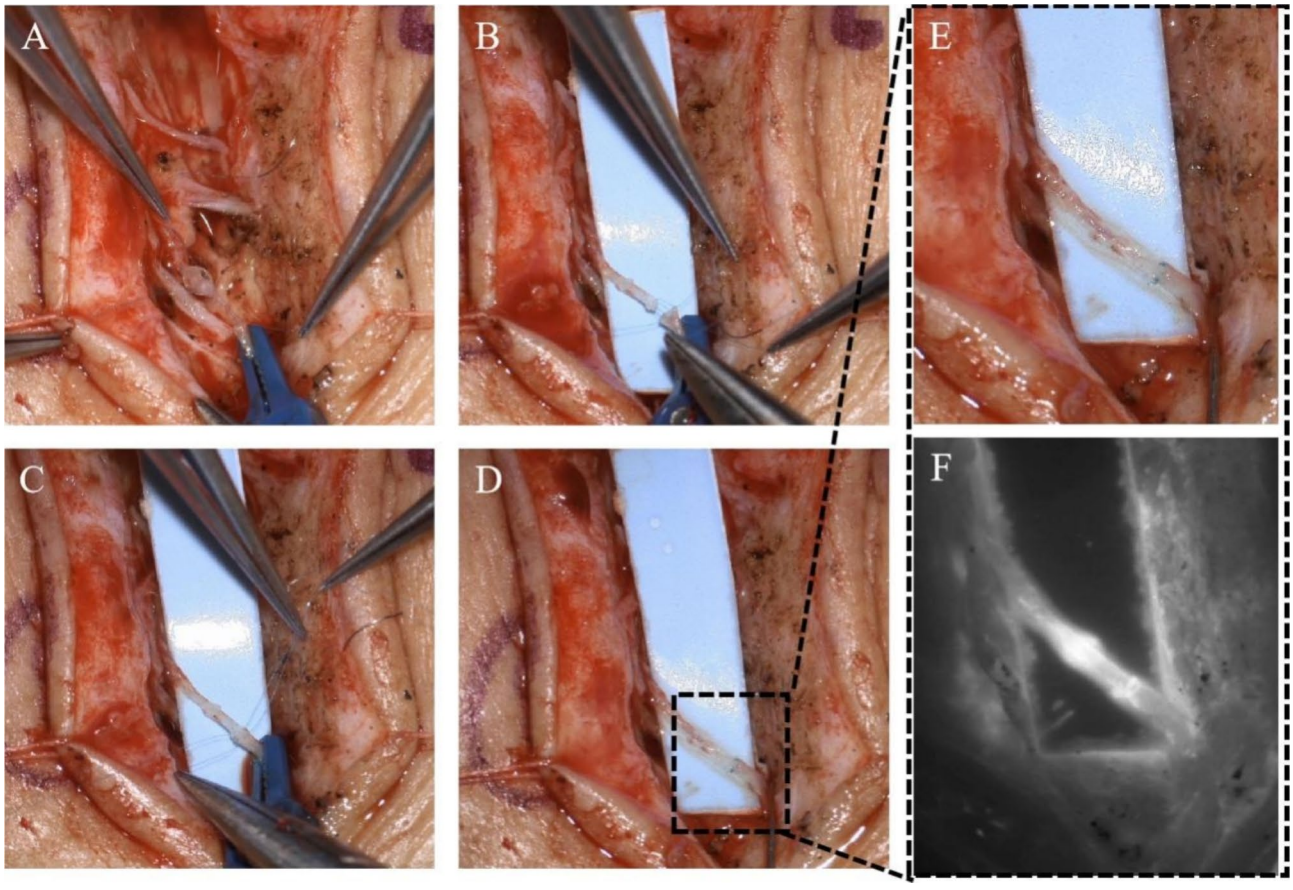

Fig. 2 **A**: The suture enters from the distal end of the vein and exits from the proximal end of the lymphatic vessel. **B**: Sutures are secured from the proximal end of the lymphatic vessels from the distal end of the venous vessels. **C**: The main surgeon and the assistant traction of two sutures to Overlapping the lymphatic vessels overlap the venous vessels. **D**: Complete the anastomosis. **E**: Lymphaticovenous anastomosis (LVA) showing lymphaticovenous anastomosis Overlapping. **F**: ICG lymphography showing ICG entering the vein from the lymphatic fluid after anastomosis

post-lymphaticovenous anastomosis volume reduction was measured using magnetic resonance volumetry. The reduction in volume post-lymphaticovenous anastomosis was evaluated at 1 week and 1 month post-operatively during follow-up assessments. During the follow-up process, the patients underwent assessments for volume and edema severity, and relevant data were recorded. Written informed consent was obtained from the patient for the use of these photographs (Case 1 follow-up).

Results

In this study, 17 patients with unilateral limb lymphedema underwent LVA surgery. The patients had an average age of 59.3 years, ranging from 43 to 76 years, and an average body mass index (BMI) of 24.88, with a range of 19.7 to 30.1. The mean number of LVAs performed per patient was 11.4, with a range of 9 to 16. The surgical techniques used included overlapping anastomosis, end-to-end anastomosis, and octopus anastomosis. Notably, the overlapping anastomosis technique average 5.3 min. The patients' average lymphatic drainage was 472.29 ml, ranging from 324.8 to 612.0 ml. Postoperative assessments showed a significant reduction in limb swelling in all patients. For detailed demographic and staging information Table 1.

Case 1

Patient : A 76-year-old female patient, who had previously undergone a hysterectomy and pelvic lymph node dissection due to uterine cervical cancer, presented with lymphedema in her right lower limb two months following the surgical procedure. Prior to the LVA, she had been utilizing a mild compression garment as a preventive measure and had no record of cellulitis. The stage of lymphatic dermal backflow, as determined by magnetic resonance imaging (MRI) lymphography, was stage III, illustrated in Fig. 3. The patient underwent 11 LVAs at seven different sites on her right leg, which was executed without any surgical complications. Postoperatively, compression therapy and manual lymphatic drainage were administered, there was a reduction of 612.0 ml in the volume of the affected limb.The postoperative outcome at the six-month mark is detailed in Fig. 4.

Discussion

LVA has proven to be a durable solution for limb lymphedema, enabling a significant reduction in limb volume for numerous patients [11, 12]. The find and identification of venules in close proximity to an ideal lymphatic vessel, with a size matches that of the lymphatic vessel lumen is crucial during the anastomosis process. During the anastomosis of lymphatic and venous, lumen discrepancies in size can lead to a constricted or suboptimal

Table 1 Demographics of the patients

Case NO.	Age (y) / Gender	BMI	Lymphaticovenous staging	Extremity	E- E / octopus / LOA (*n*)	E-E /Octopus/ LOA *n*/(min)	LVA Patency	Postoperative Notes	Post-LVA(ml), follow-up
Patient1	64 / F	22.4	I	Left leg	6 / 0/ 4	13 / 0 / 7	BF(-), ICG (+)	NS	449.0
Patient2	76 / F	23.4	III	Right leg	6 / 0 / 5	10 / 0 / 6	BF(-), ICG (+)	NS	612.0
Patient3	59 / F	25.4	II	Right leg	7 / 0 / 3	12 / 0 / 8	BF(-), ICG (+)	NS	570.0
Patient4	60 / M	26.0	II	Right leg	5 / 2 / 3	11 / 13 / 7	BF(-), ICG (+)	NS	520.0
Patient5	49 / F	19.7	I	Left leg	4 / 0 / 6	12 / 0 / 6	BF(-), ICG (+)	NS	521.0
Patient6	51 / F	28.0	II	Right leg	6 / 0 / 4	12 / 0 / 6	BF(-), ICG (+)	NS	455.0
Patient7	43 / M	30.1	II	Left leg	3 / 5 / 3	11 / 13 /6	BF(-), ICG (+)	NS	539.0
Patient8	60 / F	25.7	II	Right leg	2 / 2 / 5	10 / 15 / 5	BF(-), ICG (+)	NS	530.0
Patient9	65 / F	29.2	I	Right leg	6 / 0 / 4	13 / 0 / 6	BF(-), ICG (-)	Leakage sutured	480.0
Patient10	55 / F	24.8	II	Right arm	5 / 2 / 7	13 /18 / 5	BF(-), ICG (+)	NS	475.0
Patient11	67/ M	25.8	I	Right leg	2 / 5 / 4	10 /13 / 6	BF(-), ICG (+)	NS	324.8
Patient12	68 / F	26.8	II	Left leg	3 / 6 / 7	10 /11 / 5	BF(-), ICG (+)	NS	467.8
Patient13	70 / F	22.1	I	Right leg	2 / 4 / 6	11 / 15 / 6	BF(-), ICG (+)	NS	425.0
Patient14	76 / F	25.2	II	Left arm	3 / 5 / 8	9 / 15 / 5	BF(-), ICG (+)	NS	490.1
Patient15	52/ M	22.3	I	Right arm	4 / 3 / 5	9 / 15 / 5	BF(-), ICG (+)	NS	329.2
Patient16	71 / F	21.8	I	Left leg	4 / 5 / 3	11 / 13 / 6	BF(-), ICG (+)	NS	431.0
Patient17	72 / F	24.3	I	Left leg	3 / 2 / 6	11 / 13 / 6	BF(-), ICG (+)	NS	410.0

y: year, F: female, M: male, n:number, LOA: Overlapping anastomosis, E-E: end-to-end anastomosis, Octopus: octopus anastomosis, Post ~ LVA: Post ~ LVA volume reduction Follow-up (30 day), BF: lymphatic vessel backflow, ICG: indocyanine green lymphangiogram; NS, nothing significant

None

Fig. 3 Lower limbs magnetic resonance imaging (MRI) lymphography

Fig. 4 Patient1 76-year-old female was confirmed with lymphoscintigraphy stage III for right lower limb Extremity Lymphedema. Preoperative photo (left); 6 months post-LVA follow-up (right). LVA, lymphaticovenous anastomoses

anastomosis, impacting lymphatic function and the surgical outcome [13–16].

In LVA surgery, the lumen of the lymphatic vessels used for LVA is usually less than l mm [17, 18], and despite the use of microscopic surgical anastomosis technique [7, 19, 20], embolism may occur with a higher number of sutures [21, 22]. Reducing the number of sutures not only reduces the suturing time but also it simplifies the complexity of microsurgical anastomosis. Compared with the traditional LVA anastomosis technique [23–28], the Overlapping technique is easier to operate and uses only traction sutures to shorten the suture time and reduce the error rate caused by multiple needle penetration sutures.

When lymphatic collecting vessel was smaller than the recipient vein, recommend using overlapping anastomosis, as it effectively addresses this mismatch and serves as a valuable complement to end-to-end anastomosis. The overlapping techniques reduces the number of sutures for anastomosis also reduces reducing the risk of thrombosis

at the anastomosis site. In this study, initial intraoperative ICG results have indicated the effectively and safety of using this technique for anastomosis. However, further research is required to explore long-term outcomes due to limited patient numbers and follow-up duration.

According to the literature, the average suturing time for the traditional LVA anastomosis technique ranges from 10 to 25 min [29]. The Overlapping technique optimizes the anastomosis procedure. The surgery operator can complete the procedure more smoothly by traction suture to Overlap the lymphatic vessel into the vein. The overlapping anastomosis that the outer wall of the lymphatic vessel and the inner wall of the vein overlap to avoid leakage of fluid. In the present study, the mean time of the Overlapping anastomosis was 5.3 min. The Overlapping anastomosis reduces the damage caused by repeated needle insertion and removal of the original suture compared to the traditional anastomosis method.

Conclusions

The present study validates the efficacy and safety of overlapping techniques in LVA technology, thereby expanding the range of applicable anastomosis techniques in complex intraoperative scenarios and offering a valuable addition to the existing LVA technique.

Abbreviations

LVA	Lymphaticovenous Anastomosis
CDT	Complex decongestion therapy
MRI	Magnetic resonance imaging
LOA	Overlapping anastomosis
E-E	End-to-end anastomosis
Octopus	Octopus anastomosis
BF	Lymphatic vessel backflow
ICG	Indocyanine green lymphangiogram

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12893-024-02568-z.

Supplementary Material 1

Author contributions

Cheng Wang and Bowen Li: conceived and designed the experiments, performed the experiments, analyzed and interpreted the data, and wrote the paper. Zhumao Zhong and Youmao zheng: conceived and designed the experiments; Junbo Liang, Chong Liu: Performed the experiments; Wrote the paper.

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Data availability

Data is provided within the manuscript or supplementary information files.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of [The Taizhou Hospital of Zhejiang Province affiliated with Wenzhou Medical (K20230505)], and informed consent was obtained from all participants involved in the study.

Consent for publication

The manuscript is approved for publication by all the authors. Written informed consent was obtained from the patients and/or their legal guardiansfor publication, and any accompanying images, sex, age of these patients.

Competing interests

The authors declare no competing interests.

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