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Breast

Indocyanine Green Lymphography–guided Lymphatic Vessel Suture Ligation for Superficial Abdominal Flap Donor Site for Breast Reconstruction

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Summary: Autologous breast reconstruction using the abdominal flap based on the superficial system has the potential to minimize donor-site morbidity. Although efforts to improve its transfer have been focused, there have been scarce attempts to further reduce donor-site complications in the abdomen. Seroma formation is a significant complication after the superficial based abdominal flap harvest. The authors report our novel technique to address this issue. Using indocyanine green (ICG) lymphography, we identified lymphatic leakage sites in the abdominal donor site and repaired them by selective suture: ICG-guided lymphatic vessel suture ligation (ICG-LVSL). We performed ICG-LVSL for 10 patients who underwent breast reconstruction using the superficial abdominal flap and compared the incidence of seroma development between ICG-LVSL and non-LVSL groups. After propensity score matching, nine patients remained in each group. The ICG-LVSL group experienced lower incidence of seroma formation (0 versus 55%, P <0.01). The ICG-LVSL technique may be useful for reducing donor-site morbidity of the superficial abdominal flap. *(Plast Reconstr Surg Glob Open 2024; 12:e6051; doi: 10.1097/GOX.0000000000006051; Published online 9 August 2024.)*

CONCISE PRESENTATION OF UNIQUE IDEA, INNOVATION, OR TECHNIQUE

The abdominal flap based on the superficial inferior epigastric artery (SIEA) or superficial circumflex iliac artery (SCIA) is considered a reliable option for autologous breast reconstruction with reduced donor-site morbidity.[1–3] However, compared with the deep inferior epigastric artery perforator flap, seroma is more likely to develop after harvesting the superficial abdominal flap (SIEA, SCIP, and SIEA-SCIP flaps), resulting in frequent clinic visits.[4] This may be because the lymphatic vessels adjacent to the SIEA or SCIA are traumatized during dissection.[5,6] We aimed to minimize the donor-site morbidities of the superficial abdominal flap and make it an "ideal" flap. We hypothesized that by detecting and ligating lymphatic leakage using indocyanine green (ICG) lymphography, we could prevent seroma formation.

Under approval from the institutional review board (C-A2022-0317), we retrospectively reviewed a consecutive series of 30 patients who underwent unilateral breast reconstruction using the superficial abdominal flap from December 2019 to October 2022. Medical records were evaluated for patient characteristics, including sex, age, body mass index (BMI), history of smoking and diabetes mellitus, and history of postoperative donor-site aspiration (Table 1). Patients were divided into two groups: ICG-guided lymphatic vessel suture ligation (ICG-LVSL) and non-LVSL. We compared the incidence of postoperative abdominal aspiration.

We used the superficial abdominal flap if the SIEA or SCIA was more than 1.5 mm in diameter at the lower abdominal incision on preoperative computed tomography angiography. A standard abdominal skin paddle was marked in both groups. In ICG-LVSL group, we performed ICG lymphography after flap harvest to detect lymphatic leakage in the lower abdominal fat. [**See Video (online),** which displays ICG-LVSL. Lymphatic leakage

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was identified around the pedicle dissection site on ICG lymphography.]

A total of 0.2 mL (5 mg/mL) of ICG dye (Diagnogreen 0.25%; Daiichi Pharmatical, Tokyo, Japan) was injected subcutaneously into the first and fourth web spaces of the foot and the medial and lateral malleoli. Five minutes later, the inguinal region was examined using a near-infrared fluorescence imaging device (Lightvision; Shimadzu Corporation, Kyoto, Japan). We wiped the inguinal fat with gauze to see whether the fluorescence leaked out or not (Fig. 1). Then, 0.2 mL of ICG dye was injected subcutaneously around the donor site. We wiped the groin fat with gauze again and checked whether the fluorescence oozed out. If the fluorescence was stuck, we sutured it with 3-0 Vicryl.

A layered closure of the abdomen was performed, consisting of multiple 3-0 polydioxanone suture buried sutures and 5-0 nylon skin sutures. Two 5.0-mm closed suction drains were placed in the abdominal surgical site and brought out through the lateral poles of the suprapubic scar line.

The patient was on bed rest for 1 day postoperatively and resumed ambulation on the second day. Abdominal compression was applied for 4 weeks. The drains were removed when the drainage amount was less than 30 mL per day for 2 consecutive days. During outpatient follow-up, an ultrasound was conducted if a seroma was suspected on a physical examination. If the volume was calculated to be greater than 30 mL, ultrasound-guided aspiration was performed. Aspiration was repeated until the seroma subsided.

Takeaways

Question: Does ICG-guided lymphatic vessel ligation reduce the incidence of postoperative seroma formation in the SIEA flap donor site?

Findings: ICG-guided lymphatic vessel suture ligation (ICG-LVSL) was performed for 10 patients who underwent breast reconstruction using the superficial abdominal flap, and the duration of drain stay and the rate of seroma development between ICG-LVSL and non-LVSL groups were compared. After propensity score matching, nine patients remained in each group. The ICG-LVSL group experienced lower incidence of seroma formation (0 versus 55%, $P < 0.01$).

Meaning: The ICG-LVSL technique may be useful for reducing donor-site morbidity of the superficial abdominal flap.

Table 1. Background Characteristics of All Patients and 1:1 Propensity Score-matched Patients

	All Patients					1:1 Propensity Score-matched Patients				
	Non-LVSL, n = 20		ICG-LVSL, n = 10		Absolute Standardized Difference (ASD)* (%)	Non-LVSL, n = 9		ICG-LVSL, n = 9		ASD* (%)
Age, y										
<55	16	(80.0%)	7	(70.0%)	23.2	7	(75.0%)	7	(75.0%)	0.0
≥55	4	(20.0%)	3	(30.0%)	23.2	2	(25.0%)	2	(25.0%)	0.0
BMI, kg/m^2										
<25.0	16	(80.0%)	9	(90.0%)	28.3	8	(87.5%)	8	(87.5%)	0.0
≥25.0	4	(20.0%)	1	(10.0%)	28.3	1	(12.5%)	1	(12.5%)	0.0
Smoking history	2	(10.0%)	1	(10.0%)	0.0	1	(12.5%)	1	(12.5%)	0.0
Diabetes	0	(0%)	0	(0%)	0.0	0	(0%)	0	(0%)	0.0

Data are presented as n (%).
*An ASD of ≤10% denotes a negligible difference between the two groups.

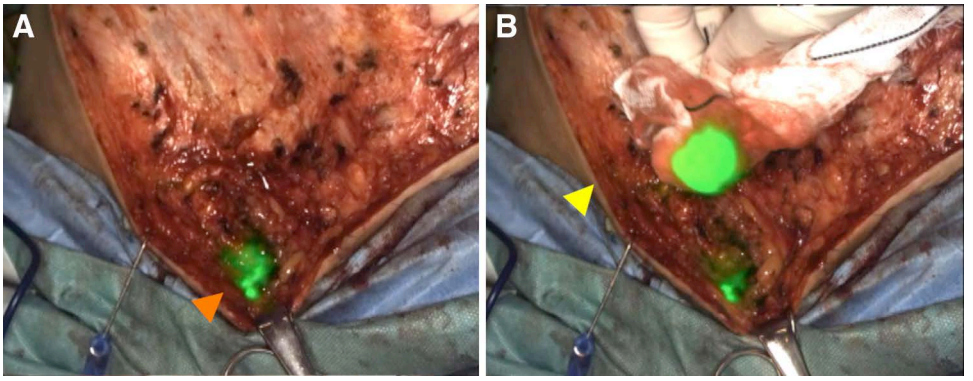

Fig. 1. Detection of lymphatic leakage in the donor site. Overlayed optical and near-infrared fluorescence images. A, After injection of ICG dye into the foot and the surrounding tissues, ICG lymphography revealed a leak at the pedicle dissection site (orange arrowhead). B, Gauze wiping of the enhanced site differentiated leaking from the lymph nodes (yellow arrowhead).

Table 2. Comparisons of Outcomes between the ICG-LVSL Group and Non-LVSL Groups in All Patients and 1:1 Propensity Score-matched Patients

	All Patients					1:1 Propensity Score-matched Patients				
	Non-LVSL, n = 20		ICG-LVSL, n = 10			Non-LVSL, n = 9		ICG-LVSL, n = 9		
	n	(%)	n	(%)	*P*	n	(%)	n	(%)	*P*
Postoperative aspiration	8	(40.0)	0	(0.0)	<0.01	5	(56.0)	0	(0.0)	<0.01

Propensity score matching was performed using one-to-one nearest neighbor matching without replacement. A logistic regression model was used to calculate the propensity scores. Predictor variables included age, BMI, history of smoking, and history of diabetes. Age and BMI were divided into two groups (< 55 and ≥ 55 years; < 25.0 and ≥ 25.0 kg/m^2, respectively). Each patient in the ICG-LVSL group was matched to a patient in the non-LVSL group, with the closest estimated propensity score within a caliper equal to 0.2 of the pooled standard deviation of the estimated logit of the propensity score. The C-statistic was calculated using the area under the receiver operating characteristic curve. A standardized difference of 10% indicated a negligible difference. Fisher exact test and *t* test were used to compare proportions of categorical variables and means of continuous variables, respectively. *P* values of 0.05 or less were considered statistically significant. R (version 4.3.0) was used for data analysis.

A total of 30 patients underwent unilateral superficial abdominal flap breast reconstruction (Table 1). ICG-LVSL was performed in 10 women (33%). The ICG-LVSL group had six SIEA flaps, two SIEA-SCIP-combined flaps, and two SCIP flaps; the non-ICG-LVSL group had six SIEA flaps, six SIEA-SCIP-combined flaps, and eight SCIP flaps. One-to-one propensity score matching selected nine pairs. The C-statistic for goodness of fit was 0.8.

The mean follow-up was 28.1 months (SD = 9.4): ICG-LVSL group, 19.5 months (SD = 5.6); non-ICG-LVSL group, 32.4 months (SD = 7.8). The incidence of postoperative aspiration was lower in ICG-LVSL group (0 versus 55%, $P < 0.01$; Table 2). There was no complication related to the ICG injection. No patient developed lower extremity lymphedema.

DISCUSSION

The superficial abdominal flap potentially minimizes donor-site morbidity and allows for rapid flap harvesting compared with the deep inferior epigastric artery perforator flap.[1–3] Although several studies have addressed the technical challenges of its transfer, to our knowledge, efforts to reduce donor-site morbidity have scarcely been reported. We previously reported that the SIEA/SCIA-based abdominal flap caused donor-site seroma more frequently.[4] We hypothesized that this was due to trauma to the lymphatic vessels during pedicle dissection. Hamdi et al described a method to prevent seroma after harvesting vascularized lymph nodes.[7] However, this method of leaving the upper abdominal fat and inserting it into the cavity leads to deformity of the flap, which is expected to affect the contour of the breast. We present a simple and easy technique by modifying the reverse lymph node mapping technique using ICG.[8]

ICG dye was injected to visualize leakage from two possible causative lymphosomes: leg and groin. Thus, we were able to accurately suture-ligate the leakage sites. Quilting suture may prevent seroma,[9] but our technique specifically focuses on the lymph-leaking sites. In the present study, we injected ICG after flap harvest. Injecting ICG before flap elevation could help in identifying nearby lymphatic vessels before they are injured. However, this approach might lead to misinterpretation of the flap perfusion on ICG angiogram due to the brightly enhanced lymphatic vessels: subcutaneously injected ICG stays longer than that injected intravenously. We routinely perform ICG angiogram after the flap elevation to confirm the flap perfusion[10] and prioritize the flap survival. Therefore, we performed subcutaneous injection of ICG after the flap transfer to the breast.

This study includes some limitations. All patients were Asian women without a history of diabetes, and most of them had a BMI lower than 25 kg per m^2, which may impact the generalizability of our results to different populations. The small number of patients included, along with the potential for unkown confounding factors due to the absence of an RCT, could impact the reliability of the findings. For a more rigorous statistical analysis, further research involving a larger number of patients is necessary.

In conclusion, our novel technique that minimizes fluid accumulation in the abdominal donor site may make the superficial abdominal flap more ideal as a donor site for breast reconstruction.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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