

# Lymphatic-based Lymphosome: A Novel Hypothesis with Clinical Implication for Supermicrosurgical Lymphaticovenous Anastomosis

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**Summary:** Understanding the anatomical territories drained by lymphatic vessels (LVs) is essential for a better comprehension of lymphatic anatomy and functionality, and for performing lymphatic procedures such as lymphaticovenous anastomosis (LVA). However, current concepts regarding the lymphatic territory are insufficient to explain some of the clinical observations. As shown in the figures, within one incision for the LVA, one to two lymphatic vessels (LV) remained unenhanced on indocyanine green (ICG) lymphography, whereas the rest of the LVs were enhanced. To answer this question, one must examine the concept of the lymphosome, first described by Suami, defined as a particular region drained by LVs into the same subgroup of regional lymph nodes (LNs) (eg, superficial groin LNs). Suami's lymphosome concept represents "LN-based lymphosomes." In addition, Shinaoka identified four distinct lymphatic groups (anteromedial, anterolateral, posteromedial, and posterolateral) in the lower limbs after ICG injection. This represents the concept "group-based lymphosomes." Nevertheless, neither the LN- nor group-based lymphosome concepts offer an appropriate explanation for the clinical findings described above. In addition to the aforementioned lymphosome concepts, the author proposes a novel hypothesis called "lymphatic-based lymphosome," which considers each LV as a single lymphosome. Therefore, the normal-type LV remained unenhanced when ICG was not injected into the draining territory. To enhance post-LVA outcomes, an even distribution of anastomoses to different group-based lymphosomes is important, as is avoiding performing all anastomoses onto a single LV or within the same group-based lymphosome. (*Plast Reconstr Surg Glob Open* 2023; 11:e5503; doi: 10.1097/GOX.0000000000005503; Published online 22 December 2023.)

## INTRODUCTION

The lymphosome concept,<sup>1</sup> introduced by Suami, is of paramount importance to the understanding of lymphedema and lymphatic surgery, namely supermicrosurgical lymphaticovenous anastomosis (LVA). However, with the accumulation of LVA performed (>2600 anastomoses), the author felt that a more refined definition of the

lymphosome may be needed to explain some of the clinical findings.

As shown in **Figure 1**, four lymphatic vessels (LVs) and a recipient vein were identified after meticulous dissection in preparation for LVA in the lower extremity. All four LVs had similar gross appearance under a surgical microscope (Pentax 900; Carl Zeiss AG, Oberkochen, Germany). According to the NECST classification,<sup>2</sup> these four LVs can be classified as normal-type LVs (**Fig. 1A**). Under indocyanine green (ICG) lymphography, the fourth LV identified (LV4) remained unenhanced after ICG was injected into the first and third webspaces on the foot (**Fig. 1B**). Theoretically, normal type LVs are considered functional and should be enhanced by ICG. Why did LV4 remain unenhanced but the other three LVs (LV1-LV3) did not?

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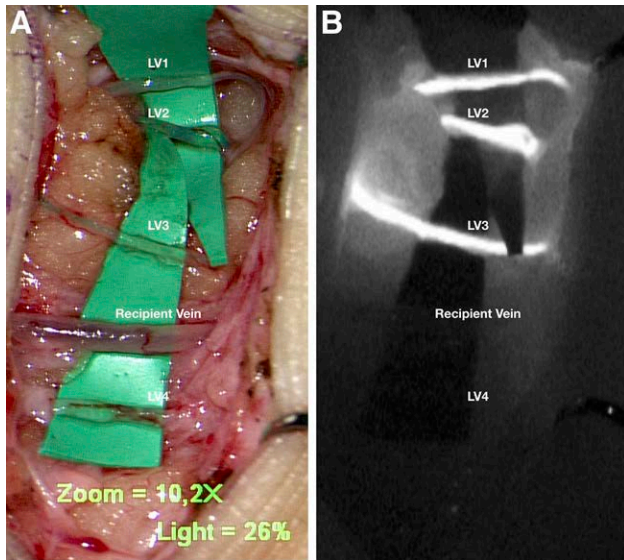
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**Fig. 1.** A, Four LVs and a recipient vein are identified after meticulous dissection in preparation for LVA in the lower extremity. According to the NECST classification, these four LVs can be classified as normal-type LVs. B, the fourth LV identified (LV4) remained unenhanced, whereas the rest of the LVs were enhanced under ICG lymphography.

Similar findings can be identified in [Figures 2 and 3](#), demonstrating that this observation is neither a common nor a rare finding (See [Video \[online\]](#), which displays synchronized video footage under normal and ICG-enhanced modes, as shown in [Fig. 3](#)).

## DISCUSSION

The concept of the lymphosome was first described by Suami, based on the anatomical location of the lymph nodes (LNs). Lymphosomes are defined by the LVs in a particular region connecting or draining to the same subgroup of regional LNs.<sup>3,4</sup> For the upper and lower limbs, the dominant lymphatic basins include axillary and superficial inguinal nodes.<sup>4</sup> Because this concept is based on LNs, it is fair to say that Suami's lymphosome concept represents "LN-based lymphosomes."

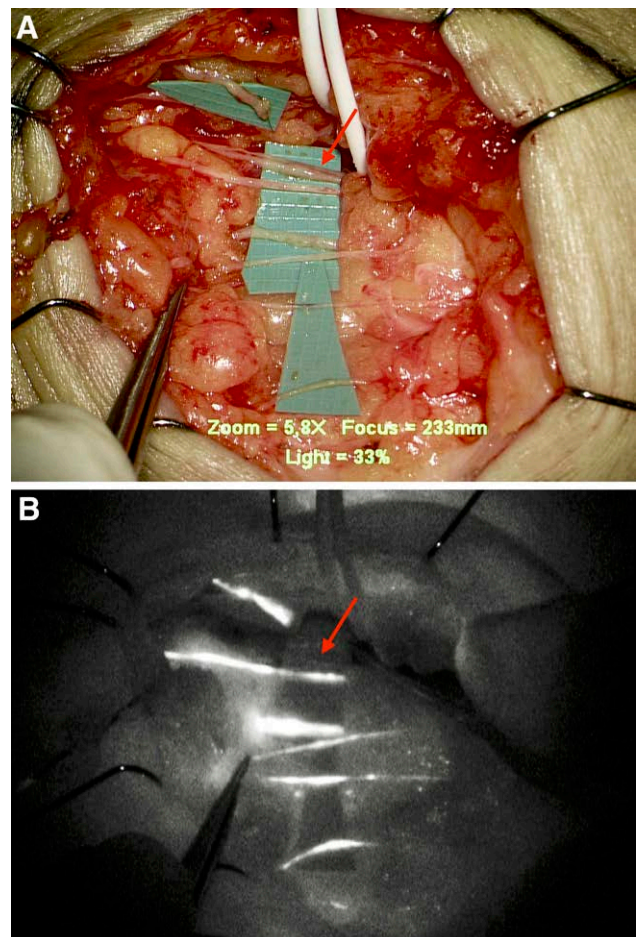
In contrast, with fresh human cadavers, Shinaoka attempted to determine different groups of LVs in the lower extremity by injecting ICG into 19 different points around the foot in a circumferential orientation, according to anatomical landmarks. Four distinct lymphatic groups were identified: anteromedial, anterolateral, posteromedial, and posterolateral groups.<sup>5</sup> During the injection, each lymphatic vessel was found to have an independent origin in the foot. The LVs seemed to branch and converge throughout their course; however, interconnections with adjacent LVs were uncommon in producing a network. These characteristics allowed for the categorization of the lymphatic pathways in the lower limbs into groups.<sup>6</sup> Compared with Suami's LN-based lymphosome theory, Shinaoka's concept represents "group-based lymphosomes." Nevertheless, neither the LN- nor

## Takeaways

**Question:** Understanding the anatomical territories drained by lymphatic vessels (LVs) is essential for a better comprehension of lymphatic anatomy and functionality, and for performing lymphatic procedures such as lymphaticovenous anastomosis (LVA). However, current concepts regarding the lymphatic territory are insufficient to explain some of the clinical observations.

**Findings:** A newly defined "lymphatic-based lymphosomes" concept.

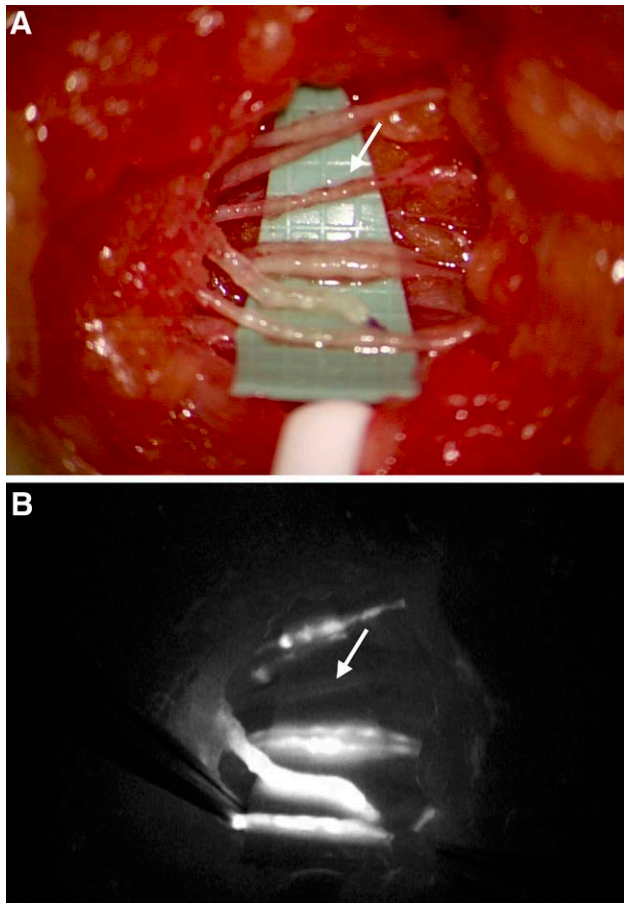
**Meaning:** To enhance post-LVA outcomes, an even distribution of anastomoses to different group-based lymphosomes is important, as is avoiding performing all anastomoses onto a single LV or within the same group-based lymphosome.



**Fig. 2.** A, Eight LVs are identified in the incision near the groin area. However, two LVs remained unenhanced (B) on ICG lymphography (arrow).

group-based lymphosome concepts offer an appropriate explanation for the findings shown in [Figures 1–3](#).

Hence, in addition to LN- and group-based lymphosomes, we propose a novel hypothesis called "lymphatic-based lymphosomes." Understanding the angiosome



**Fig. 3.** A, Seven LVs are identified in an incision near the groin area. However, but one LV remained unenhanced (B) on ICG lymphography (arrow).

concept is essential to better comprehend the concept of “lymphatic-based lymphosomes.” Taylor’s angiosome theory says that the anatomical territory in the skin and deep tissues is being “perfused” by a source artery (perforator),<sup>7–9</sup> whereas lymphatic-based lymphosomes represents the anatomical territory being “drained” by a particular LV. Thus, each LV is considered a single lymphosome. The difference perhaps is that angiosomes have an adjoining territory, which too can be perfused if choke vessels open up, whereas lymphosomes are remarkably isolated with scanty interconnections.<sup>1,4</sup> The applied importance of this research is that to enhance post-LVA outcomes, an even distribution of anastomoses to different group-based lymphosomes is important, as is avoiding performing all anastomoses onto a single LV or within the same group-based lymphosome.”

This concept is in line with our previous study, which discussed what defines a functional LV, that lymphatic flow-positive but non-ICG enhanced LVs should also be considered functional.<sup>10</sup> Seki’s three-line strategy for treating breast cancer-related lymphedema also proposes a similar concept.<sup>11</sup> We will present our results in the near future regarding the placement of anastomoses in different group-based lymphosomes, as well as their impact on outcome.

In conclusion, the anatomical territories drained by LN-based lymphosomes (Suami), group-based lymphosomes (Shinaoka), and lymphatic-based lymphosomes were large (whole limb), medium (regional), and small (single LV), respectively. Thus, understanding these concepts is essential for a better understanding of lymphatic anatomy and functionality, and for performing LVA.

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#### DISCLOSURE

*The author has no financial interest to declare in relation to the content of this article.*

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