From Theory to Evidence: Long-Term Evaluation of the Mechanism of Action and Flap Integration of Distal Vascularized Lymph Node Transfers

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Introduction
Non-anatomic (distal) placement of vascularized lymph node (VLN) transfers have shown efficacy in the treatment of extremity lymphedema, but the mechanism by which these flaps provide relief of lymphedema remains unclear. Intrinsic lymphovenous connections have been previously shown to exist in the transferred flap. But, the long-term interaction of the VLN flap and surrounding lymphedematous extremity has not been previously investigated.

Methods
A retrospective review of a prospective maintained database of patients who underwent VLN transfer was evaluated. Patients who underwent distal VLN transfer and had greater than one-year follow-up were identified. Lymphodynamic evaluation was performed using indocyanine green (ICG) on identified patients. Migration direction of dye and latency period was evaluated.

Results
Twenty patients were identified and met inclusion criteria. Average long-term follow-up was 27.3 months. The average circumference reduction of the affected extremity was 40.5%. Indocyanine green appearance within the VLN flap was found in all patients occurring on average in 178.3 seconds. In all cases, flow occurred in the distal direction (toward the flap) with proximal placement of dye. Latency period was found to inversely correlate with circumference reduction ($p<0.01$).

Conclusion
Distal, non-anatomic placement of VLN flaps provide sustained limb circumference reduction in extremity lymphedema patients with at least one year follow-up. Flap integration with the recipient site reliably occurs as witnessed with consistent ICG drainage, and occurs in the gravity-dependent direction. Faster clearance of ICG will result with improved limb circumference reduction.