



Proposed pathway and mechanism of vascularized lymph node flaps



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HIGHLIGHTS

- Vascularized submental lymph node flap is effective for limb lymphedema.
- Flaps containing lymph nodes absorbed more fluid than those that did not.
- A mechanism and pathway is proposed based on the results of this study.

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ABSTRACT

Objective. To investigate the pump mechanism and pathway of lymph transit in vascularized lymph node flaps.

Background. Microsurgical treatment of lymphedema with vascularized lymph node transfer can improve signs and symptoms of disease, but the pathways and mechanisms of these flaps warrant further exploration.

Methods. (Animal model) 72 flaps were raised in 18 rats: 36 groin flaps contained lymph nodes (LN), 36 deep inferior epigastric artery perforator flaps did not (non-LN). Indocyanine green (ICG) was added into normal saline (NS), 1%, 3%, 5%, 7% and 10% albumin. Three rats were assigned to each group. LN and non-LN flaps were submerged in solution and surveyed for venous fluorescence. In the 7% albumin and NS groups, volumetric change of solution was measured. (Human model) A similar experiment was performed in humans using five submental LN flaps.

Results. (Animal model) Fluorescence was detected in the venous pedicle of LN flaps submerged in 5%, 7% and 10% albumin, and half of flaps submerged in 3% albumin. Fluorescence was not detected in LN node flaps submerged in ICG-containing NS or 1% albumin solution. Fluorescence was not detected in non-LN flaps. There was greater volume reduction with LN flaps than non-LN flaps ($p < 0.001$). (Human model) Fluorescence was detected in the venous pedicle of all flaps immersed in lymph.

Conclusions. ICG fluorescence was detected in the venous pedicle of rat and human LN flaps submerged in lymph or albumin when the concentration was greater than 3%. Based on these results, a pathway for lymphatic uptake is presented.

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1. Introduction

Lymphedema is a complex proliferative process that results from disruptions of the lymphatic circulation, affecting as many as five million Americans, and 200 million worldwide [1–2]. Disease onset may be insidious, with progressive swelling followed by inflammation, fat hypertrophy and fibrosis. Lymphedema may be primary or idiopathic, but more commonly results from lymphadenectomy and radiation.

According to studies, patients who had gynecological surgery and lymphadenectomy, as well as those who received pelvic radiation therapy have 10–49% chance of developing lower limb lymphedema. Upper limb lymphedema is also quite common for those who underwent mastectomy, accounting for an estimated 4–62.5% among patients who have received underarm lymphadenectomy and radiotherapy [3].

Preventative strategies are generally more effective than strategies with curative intent. Non-operative management may be mechanical or medical. The most effective surgical strategies are bypass procedures like lymphovenous anastomosis (LVA) or lymphatic tissue auto-transplantation (vascularized lymph node transfer, VLN) [1,4–10]. The mechanism of VLN flaps transferred distally to the affected limb was previously proposed: vascularized lymph nodes act as the motor of a

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