


RESEARCH ARTICLE

Efficacy validation of a lymphatic drainage device for lymphedema drainage in a rat model

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Abstract

Background: Vascularized lymph node transfer (VLNT) is an effective surgery for extremity lymphedema. This study evaluated a lymphatic drainage device (LDD) for the drainage of accumulated fluid into the venous system.

Methods: Micropore filtering membranes with pore sizes of 5, 0.65, and 0.22 μm polyvinylidene difluoride, and 0.8 μm Nylon Net Filter were evaluated to determine the in vitro efficiency of drainage flow of an LDD. The two superior membranes were further used for the evaluation of the inflow and outflow of the LDD in vivo using 5% albumin.

Results: At 5 minutes, the volumes drained with 5, 0.65, and 0.22 μm polyvinylidene difluoride and 0.8 μm nylon membranes were 15.2, 2.77, 2.37, and 0.59 mL, respectively ($P < .01$). At 10 minutes, the collected volumes of 5 and 0.65 μm polyvinylidene difluoride were 1788 and 1051 μL ($P = .3$). The indocyanine green fluorescence was detected at 50 seconds for the 5 μm polyvinylidene difluoride membrane but not for the 0.65 μm membrane.

Conclusions: The study successfully demonstrated the proof-of-concept of the LDD prototype that mimicked VLNT with drainage of 5% albumin into the venous system in a rat model.

KEYWORDS

drainage efficacy, lymph drainage device, lymphedema

1 | INTRODUCTION

Approximately 20% to 40% of individuals with breast cancer suffer from posttreatment upper extremity lymphedema, and 20% to 30% of gynecological cancer patients sustained lower extremity lymphedema.¹⁻⁴ Lymphedema is characterized by progressive swelling of the soft tissue due to the accumulation of excessive lymph fluid in the soft tissue spaces. As the condition persists, the local tissues may develop inflammation, fat hypertrophy and fibrosis, which result in a swelling and a heavy and tight limb. Understandably, these symptoms are extremely debilitating to patients. Traditionally, nonsurgical rehabilitative treatment was preferred. These treatments include the life-long use of complex

decongestive therapy and compression garments.^{5,6} In recent years, physiological surgeries utilizing microsurgical techniques have emerged, which include lymphovenous anastomosis (LVA)⁷⁻⁹ and vascularized lymph node transfer (VLNT).^{10,11}

The technique of VLNT involves the harvesting of healthy lymph nodes from variable lymph node basins from other anatomical sites and the transfer of the vascularized lymph node flap to the recipient site and anastomosis of the donor and recipient vessels. The transferred nodes serve as a pump that bypasses the excess lymph into the venous system via natural lymphatico-venous connections within the transferred lymph nodes.^{10,12,13} VLNT has been shown to effectively improve the lymphatic drainage in lymphedematous limbs, with a