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CASE REPORT
Reconstructive

Radiographic Enhancement of Lymph Nodes 9 Months after Omental Lymph Node Transfer

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Lymphedema is a frequent complication of breast cancer treatment. As the survival rates of breast cancer continue to increase, the number of women with lymphedema will also increase. Surgical treatment of lymphedema has made significant advances during the past 20 years, and our understanding of these procedures continues to evolve. Vascularized lymph node transfer is an increasingly popular option for surgical treatment of lymphedema; however, the mechanism behind symptomatic relief is not fully understood. A proposed theory for improvement in lymphedema symptoms is lymphangiogenesis and spontaneous regeneration of lymphatic vessels, the timing and degree of which are not well defined. We present the case of a 40-year-old woman with a 10-year history of right upper extremity lymphedema secondary to bilateral mastectomy and right axillary lymph node dissection, who subsequently underwent vascularized omental lymph node transfer and lymphovenous bypass with radiographic evidence of spontaneous lymphatic reconnection within 9 months. To our knowledge, this is the earliest reported radiographic evidence of lymphatic regeneration in a human subject to date, adding to the growing body of evidence to support the therapeutic benefits of vascularized lymph node transfers.
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Lymphedema is an increasingly common condition.[1] Although exact prevalence cannot be determined, an estimated 140–250 million people worldwide experience chronic lymphedema.[2] Breast cancer treatment in particular has high rates of lymphedema, with a pooled incidence of 21.4%.[3,4] Current surgical options include vascularized lymph node transfer (VLNT) and lymphaticovenous bypass.[4]

There are 2 main theories by which VLNT treats lymphedema.[5] One describes the transferred nodes acting as a "wick," bridging between damaged lymphatics.[5] The lymphaticolymphatic anastomoses required for bridging are thought to form secondary to vascular endothelial growth factor C (VEGF-C) release from transferred nodes.[5] The second is the "pump" theory.[4,5] Gravitational and compressive forces propel interstitial fluid toward the lymphatic flap with the transferred nodes acting as pumps. Their intrinsic lymphaticovenous connections allow for fluid transfer into the systemic circulation.[4,5]

Evidence to support these theories in humans is not conclusive. One study, where indocyanine green (ICG) was injected into the tissues of a VLNT showed uptake within the donor vein almost immediately, provides some evidence for the pump theory of VLNT; however, current understanding of how lymphatic collectors function challenges this view.[5] Evidence of integration of transferred lymph tissue into native lymphatics has been shown in animals, with histology demonstrating lymphangiogenesis.[6,7] The process was associated with increases in VEGF-C.[6,7] There are few studies in human subjects, but some have reported similar increases in VEGF-C, and evidence of lymphatic integration on lymphoscintigraphy.[8,9] This case report presents evidence of early lymphatic integration, providing some evidence toward the lymphangiogenic theory.

CASE REPORT

In 2011, a 29-year-old woman presented with a self-identified right breast mass. She underwent imaging and

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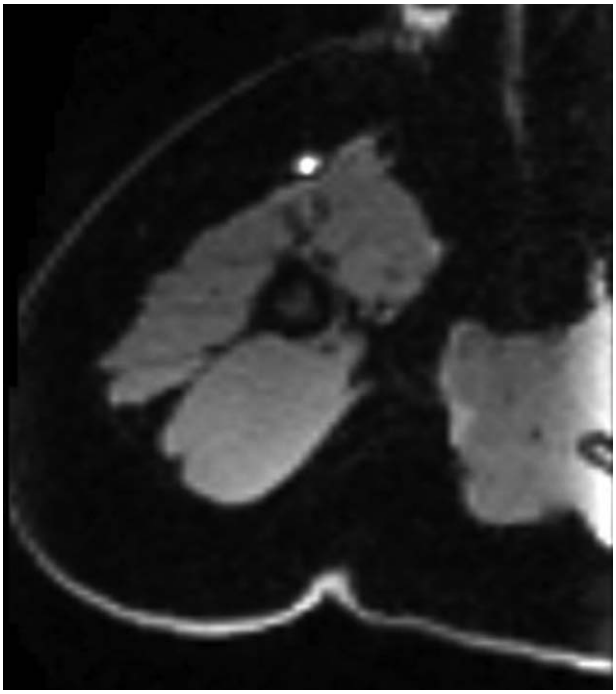

Fig. 1. Preoperative axial reformatted T1 fat-saturated image after intradermal contrast injection demonstrating no evidence of axillary lymph node enhancement.

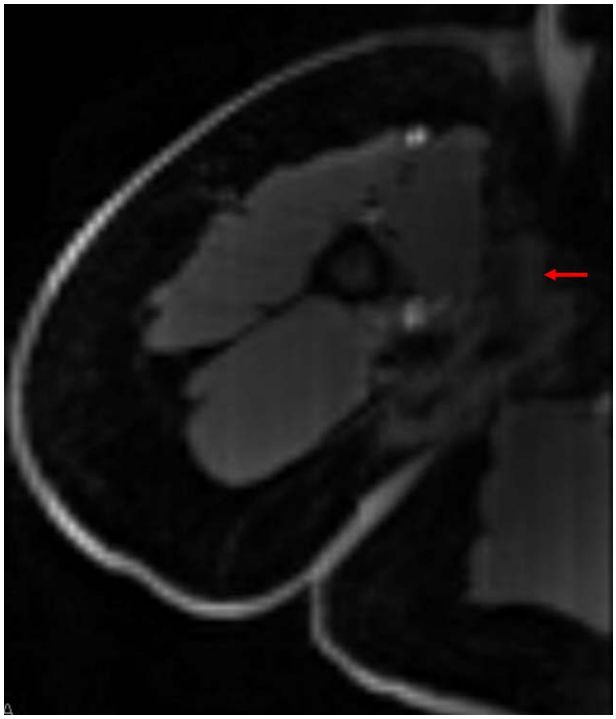

Fig. 2. Three-month postoperative axial reformatted T1 fat-saturated image after intradermal contrast injection. The red arrow demonstrates the transplanted omentum. There was no lymphatic enhancement within the omental transplant in this study.

biopsy, which revealed stage IIA, grade 2 infiltrating ductal carcinoma of the right breast. Her cancer was both estrogen and progesterone receptor positive and 3+ for human epidermal growth factor receptor 2/neu. She had no significant medical or surgical history. Family history was significant for breast cancer in her maternal grandmother, and genetic testing was negative for breast cancer gene 1 and 2. She subsequently underwent bilateral skin- and nipple-sparing mastectomies, with positive sentinel lymph node biopsy requiring completion axillary lymph node dissection in 2011. After mastectomy, she completed chemoradiation. The patient underwent multiple procedures for breast reconstruction, with final reconstruction consisting of a muscle-sparing transverse rectus abdominis free flap to the right breast and silicone implant to the left breast in 2012.

Approximately 8 years after mastectomy, the patient returned to the clinic complaining of right upper extremity swelling which interfered with her activities of daily living and work as a critical care nurse. Magnetic resonance imaging (MRI) lymphangiography was performed after intradermal injection of gadolinium contrast, which demonstrated delayed lymphatic drainage with multiple slightly dilated prominent lymphatic channels along the dorsal ulnar margin of the forearm, and areas of dermal backflow along the dorsal margin of the forearm (Fig. 1).

Approximately 6 months later (2020), she underwent open free omental flap transfer to the right axilla as well as lymphovenous bypass to the distal dorsal right forearm. (**See figure, Supplemental Digital Content 1**, which displays [A] preoperative image before omental free flap. B, Postoperative image at 6 months after omental free flap. C, Intraoperative images showing the omental flap transfer, **http://links.lww.com/PRSGO/D624**.) Nine months postoperatively, the patient experienced some symptomatic improvement; however, MRI lymphangiography was repeated to evaluate the success of the transplant and potential candidacy for additional lymphovenous bypass. Repeat MRI lymphangiography was performed after intradermal gadolinium injection (2–4 mL contrast); injections are administered by several providers in the department. The study showed decreased lymphedema, with increased lymphatic drainage in the distal forearm. There was no gadolinium enhancement of the transplanted lymph nodes (Fig. 2).

The patient was found to be a good candidate for additional lymphovenous bypass. Three months after repeat imaging, secondary lymphovenous bypass was performed along the ulnar volar wrist in 2021.

A follow-up MRI lymphangiography was done 3 months later, 9 months after the initial omental transfer. This demonstrated gadolinium enhancement of lymph nodes within the omental flap, indicating drainage from the subcutaneous injection in the hand (Fig. 3A). Another MRI lymphangiography obtained 2 years after the initial operation demonstrated further evidence of lymphatic enhancement (Fig. 3B). The study showed increased lymphatic drainage in the forearm distal to the lymphaticovenous anastomosis, as expected, given that the area is benefiting from both the lymphaticovenous anastomosis and the more proximal VLNT. One month after the

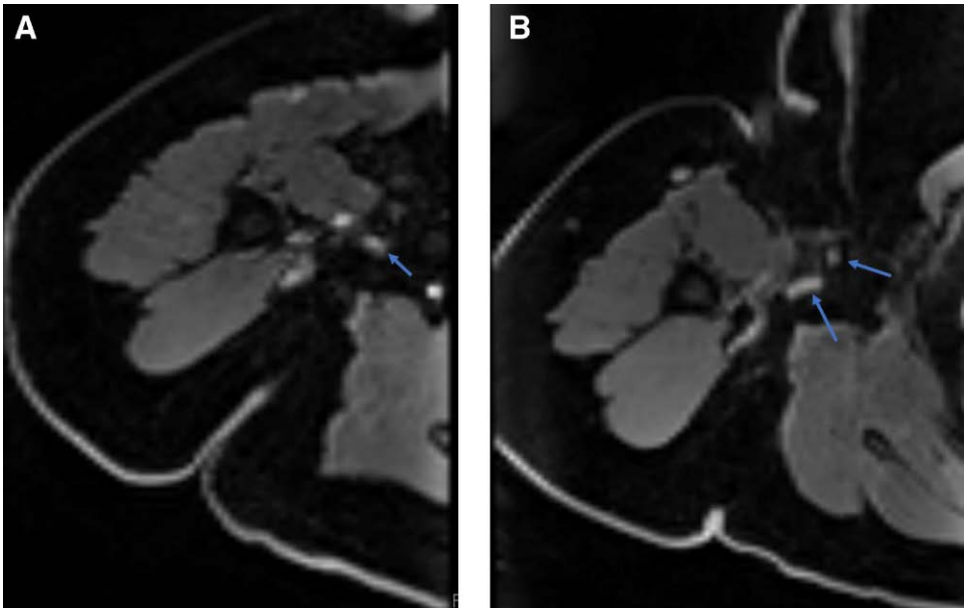

Fig. 3. Postoperative imaging. A, Nine-month postoperative axial reformatted T1 fat-saturated image after intradermal contrast injection. The blue arrow shows enhancing transplanted omental lymph nodes. B, Two-year postoperative axial reformatted T1 fat-saturated image after intradermal contrast injection. The blue arrows show enhancing transplanted omental lymph nodes.

secondary procedure, the patient endorsed symptomatic improvement and was satisfied with her results, no longer requiring compression garments while working.

DISCUSSION

VLNT for the treatment of lymphedema was first described in 1982 by Clodius et al and has become part of the gold standard for lymphedema treatment.[2] Our understanding, to date, is that symptomatic relief is due to lymphangiogenesis and spontaneous regeneration of lymphatic vessels.

This report provides some support of the lymphoangiogenesis mechanism of VLNT, as the MRI enhancement seen suggests integration of the omental flap into the patient's native lymphatics; however, we lack histopathologic evidence. Of the current minimal evidence demonstrating lymphangiogenesis after VLNT, a case series by Liu et al[9] presents a cohort, with some patients demonstrating visualization of transplanted nodes in lymphoscintigraphy. However, the first imaging follow-up was at 1 year postoperatively. Nodes were visualized in 4 of 30 patients, but all 4 demonstrated clinical improvement.[9] Our report demonstrates lymph node enhancement on MRI 9 months after omental flap, suggesting integration may occur earlier than previously thought. To our knowledge, this report describes the earliest example of lymphatic integration in a patient.

Our patient reported both clinical improvement and symptomatic reduction at 6 months postoperatively and during continued follow-up. Early lymphatic enhancement on imaging may be correlated with improved clinical outcomes, as demonstrated by this case and the series by Arrivé et al.[9] However, a similar report of lymphedema after breast reconstruction by Becker et al did not demonstrate the same correlation of clinical outcomes and node enhancement on magnetic resonance lymphangiography.[10] Further studies determining the expected timeline and frequency of lymphangiogenesis and subsequent radiologic enhancement postoperatively would be of value.

CONCLUSIONS

We present a case of lymph node enhancement on MRI 9 months after omental vascularized lymph node transplant to the right axilla. This is the earliest evidence of lymphangiogenesis after surgery. Further investigation is required for robust conclusions regarding the mechanism of treatment after VLNT.

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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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