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Reconstructive

Vascularized Omentum Lymphatic Transplantation as a Treatment for Chronic Inguinal Ulceration and Lymphedema

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Background: After tumor resection, lymphadenectomy, and radiotherapy, recurrent lymphatic fluid leakage and infection can occur in the inguinal region, contributing to severe localized tissue fibrosis. When wounds form in this region, they tend to heal slowly over extended periods, and no optimal approach for treating these complex wounds has yet been established.

Methods: Groin wound debridement and dissection of the vessels in the wound recipient site were performed by the burn surgeon. A general surgeon performed the laparoscopic partial omentum excision. One portion of the omentum was used to fill the large inguinal space, whereas the other portion was laid flat on the wound sites in the groin and anterior perineum to facilitate the restoration of appropriate lymphatic fluid reflux. The vessels of the omentum were microsurgically anastomosed with the vessels in the recipient site. Thin split-thickness slices of skin were then taken from this donor site based on the size of the wound.

Results: After the successful establishment of revascularization between the flap and recipient sites, lymphatic fluid leakage was not observed in this patient. No inguinal wounding or lymphatic exudate were evident in the patient during follow-up, and significant improvements in lymphedema of the lower extremities were evident.

Conclusions: In this article, we discuss the advantages and disadvantages of vascularized omentum lymphatic transplantation. Overall, this procedure represents a promising new approach for the treatment of refractory wounds caused by lymphatic fistulas. *(Plast Reconstr Surg Glob Open 2024; 12:e6049; doi: 10.1097/GOX.0000000000006049; Published online 15 August 2024.)*

INTRODUCTION

Ruptured inguinal wounds with ulceration and associated lymphatic fistula formation are common complications of localized cancer treatment, including radiotherapy, lymph node dissection, and inguinal tumor resection.[1] Impaired lymphatic reflux in these patients often results in lower limb lymphedema.[2]

Adequately addressing this issue requires repair of the wound tissue site and reconstruction of the local lymphatic system. Conservative measures for affected patients include bed rest, antibiotics, nutritional support, microwave therapy, manual massage, and compression therapy with elastic bandages. These strategies can resolve localized edema in approximately 80% of cases.[3] However, some researchers have asserted that these conservative measures are ineffective and associated with prolonged hospitalization, high rates of infection, and prolonged wound healing.[4] Surgical interventions are thus recommended for many patients, particularly for those with chronic ulcers associated with lymphatic leakage. Increasingly advanced microsurgical strategies, including lymphaticovenous anastomosis and vascularized lymph node transplantation (VLNT), to address lymphedema have been designed in recent years, yielding increasingly promising patient outcomes.[5] VLNT is achieved via microsurgical transfer of a flap containing the lymph node and surgical reconstruction to remediate abnormal lymphatic reflux.[6] Microsurgical experts currently agree that lymphaticovenous anastomosis is most effective during the

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early stages of lymphedema when the lymphatic vessels remain open and functional, whereas VLNT is more effective for patients with advanced lymphedema exhibiting severe damage to multiple lymphatic vessels, severe infections, and fibrosis proximal to the wound site.[7]

Although it can be effective, VLNT entails risks to the donor site, including localized scarring and the potential for iatrogenic lymphedema. The omentum is rich in vascular reticular tissue and lymphatic circulation, enabling more effective control of complex infections while resisting tumor development. The omentum also exhibits robust absorptive and exudative functionality, making it a promising donor tissue choice for VLNT.[8] In this report, we describe our experience with using the omentum to facilitate the healing of chronic ulceration caused by lymphatic fluid in light of prior reports on the application of the omentum when seeking to facilitate the healing of chronic wounds.

Takeaways

Question: How do we manage inguinal wounds with lymphatic fluid leakage and infection, as there is currently no optimal treatment available for achieving complete healing?

Findings: Vascularized omentum lymphatic transplantation was successfully used as a means of treating chronic inguinal skin ulcers and lymphatic reflux, highlighting a viable approach to the management of similarly affected patients in the future.

Meaning: A surgical innovation: utilizing the advantages of the omentum in conjunction with microsurgical techniques to address non-healing wounds resulting from lymphatic fluid leakage.

Case Presentation

The procedures performed in this study were in accordance with national and institutional ethical standards and were consistent with the 2013 revision of the Declaration of Helsinki. The patient provided written informed consent for the publication of this case report and accompanying images.

A 67-year-old man presented with recurrent ulceration and purulent discharge in the right groin that had been present for 3 years. The patient had localized stiffness of the skin and lymphedema of the lower right extremity after the resection of a testicular tumor and prolonged chemoradiotherapy 20 years prior. Three years previously, he experienced repeated rupture of the right groin with delayed healing and purulent foul-smelling discharge. Physical examination revealed a 3×3 cm ulcerated region in the medial skin of the right groin, with a small outlet and a large base. The base of the wound was gray and white in color (Fig. 1A), producing secretions and emitting an unusual odor. The skin surrounding the wound was dark red and stiff, consistent with severe fibrosis, and an abnormal swelling of the right lower limb was observed (Fig. 1B). Six months previously, the patient was treated via successive lymphatic venous anastomosis, local skin flap repair, and rectus abdominis island skin flap repair in Xijing Hospital of the Fourth Military Medical University; however, these strategies failed to reverse the observed lymphedema or ulceration. The sinus tract of the inguinal ulcer was deep, extending backward to the greater trochanter and exhibiting a large lacunar space (Fig. 1C, D). After hospitalization for 1 month and discussion with the patient and his family members, written informed consent was obtained for laparoscopic partial omentum harvesting, right groin debridement, and free vascularized omentum lymphatic transplantation. Using this strategy, the lacunar cavity was completely filled, and skin grafting was performed on the omentum surface. Most of the skin grafts remained viable 7 days after this procedure, with limited exudation that was negative for bacterial culture, and no exudation or bacterial infection was evident on day 14 after the procedure, with complete skin graft survival. On postoperative day 20, the patient was discharged, and a 6-month and 1-year follow-up visit confirmed the absence of any exudation or infection in the groin, whereas the circumference of the affected thigh was reduced by 4 cm relative to the preoperative value.

Operative Approach

This operation was performed in two stages: the first was performed by a burn surgeon, and the second was performed by a general surgeon.

Step One

Groin wound debridement was performed by the burn surgeon. Initially, the wound was washed successively with 3% H_2O_2 and normal saline. The ulcer sinus was deep in the inguinal fascia, accompanied by pronounced fibrotic scarring (Fig. 2A). After repeated rinsing with 3% H_2O_2 and normal saline to thoroughly remove any necrotic and fibrotic tissue and achieve hemostasis, the vessels in the wound recipient site were dissected. Wet gauze was used to protect the wound surface while awaiting the omentum coverage (Fig. 2B).

Step Two

A general surgeon performed the laparoscopic partial omentum excision. Initially, artificial pneumoperitoneum was established, and then a laparoscope was inserted into the incision site. No damage was observed in the mesangial or abdominal bowel tissue at the incision site. The omentum was free, and there was no apparent adhesion to the abdominal wall. Both the artery and vein of the left and right gastroepiploic vessels were identified. The vessels were clipped and transected once the recipient site was prepared. After removing the laparoscope and trocar, the umbilical incision was expanded to 5 cm, and the free omentum was removed through this incision and transferred to a lavage table where it was rinsed with heparin saline and placed in sterilized normal saline for subsequent use (Fig. 2C). After accounting for all the surgical instruments and dressings, the incisions were sutured.

Fig. 1. Preoperative wound and MRI results. A, On admission, the patient exhibited a wound in the groin with a small mouth and a large base characterized by gray-white tissue coloration and high levels of exudate production. B, The ipsilateral limb of the affected wound was abnormally swollen on admission, with a thigh circumference of 59 cm. Even after lymphatic venous anastomosis, local flap repair, and rectus abdominis island flap repair, lymph exudation from the wound site persisted. C, Intraoperatively, hemostatic forceps were used to explore the depth of the sinus at the ulcerated site. D, Magnetic resonance imaging scans at the level of the hip joint revealed an extensive ulcer extending posteriorly towards the greater trochanter, leading to the formation of a large cavity.

Step Three

One portion of the omentum was used to fill the large inguinal space (Fig. 2D), whereas the other portion was laid flat on the wound sites in the groin and anterior perineum to facilitate the restoration of appropriate lymphatic fluid reflux. Then, 9-0 sutures were used for intermittent suturing of the omentum and recipient vessels, including one artery and one accompanying vein, with intravenous administration of 500 mL of low-molecular-weight dextran. Good vascular filling was achieved, and the omentum color was normal after the vascular anastomosis (Fig. 2E). A drainage tube was placed on the wound surface, and 500 mL of normal saline containing epinephrine (1 mg) was injected into the donor area of the right thigh. Thin split-thickness slices of skin were then taken from this donor site based on the size of the wound, after which oil gauze was used to cover the donor area, and these skin grafts were applied to the groin wound site. The wound was then appropriately bandaged and fixed using mesh gauze and sterile dressing. On day 7 after surgery, the wound was opened (Fig. 2F).

OUTCOMES

On postoperative day 7, most of the skin grafts remained viable, and on day 14, circulation between the omentum and surrounding tissue was fully established with complete viability of the skin graft area and no evidence of local lymphatic effusion. On follow-up at 3 months, 6 months, and 1 year after surgery, the patient exhibited no evidence of lymphatic exudation or infection and presented with satisfactory appearance and function (Fig. 3). A significant decrease in the diameter of the affected thigh was also evident at the 6-month follow-up relative to preoperative values. Magnetic resonance imaging performed 1 year postoperatively revealed complete

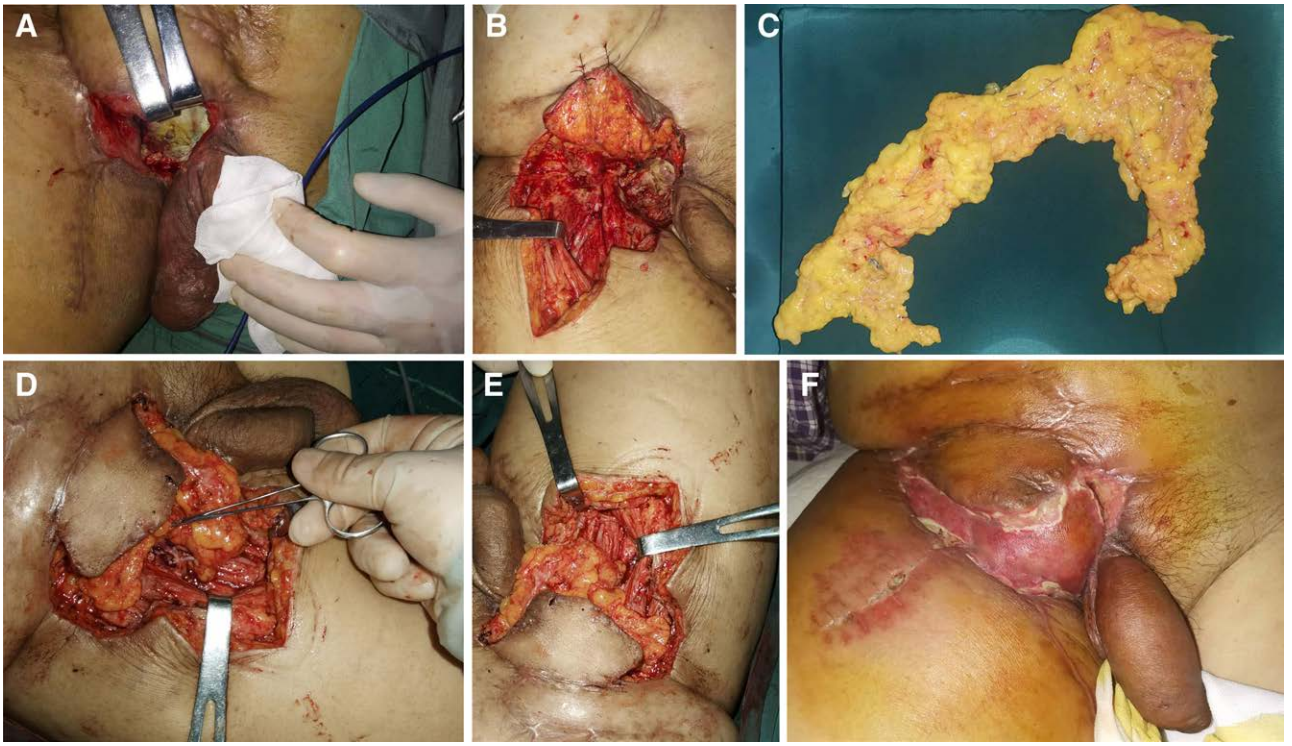

Fig. 2. Intraoperative and postoperative results. A, Intraoperatively, the ulcer sinus was found to extend deep into the inguinal fascia within the abdominal wall, with corresponding tissue scarring and fibrosis. B, The lateral circumflex femoral artery and vein can be visualized in the exposed inguinal vascular window. C, The established surgical approach was used to isolate the omentum. D, The omentum was then packed densely within the deep inguinal cavity. E, Omentum vessels were intermittently anastomosed with recipient site vessels using 9-0 sutures to join one artery and the corresponding vein. F, Wound status on day 7 postsurgery.

Fig. 3. Postoperative follow-up of 3 months and 6 months results. No evidence of lymphatic exudate or wound site infection was observed upon follow-up at 3 or 6 months postsurgery, and the patient exhibited satisfactory aesthetic and functional outcomes (A and B). C, The circumference of the affected thigh was significantly reduced to 54 cm at 6 months postsurgery, consistent with the observed improvements.

filling of the large cavity in the groin by the omentum (Fig. 4). Lymphatic nuclide imaging of the bilateral lower extremities was also performed 1 year postoperatively after the subcutaneous interdigital injection of ^{99}mTc-DX (1.5 mCi/0.2 mL) in both feet. At 15 minutes postinjection, unobstructed lymphatic reflux was evident in the lower left limb on the healthy side, with distinctly visible lymphatic vessels. Obstructed lymphatic return was still evident in the right lower extremity, and a high radioactive concentration was evident in the right groin at the site of

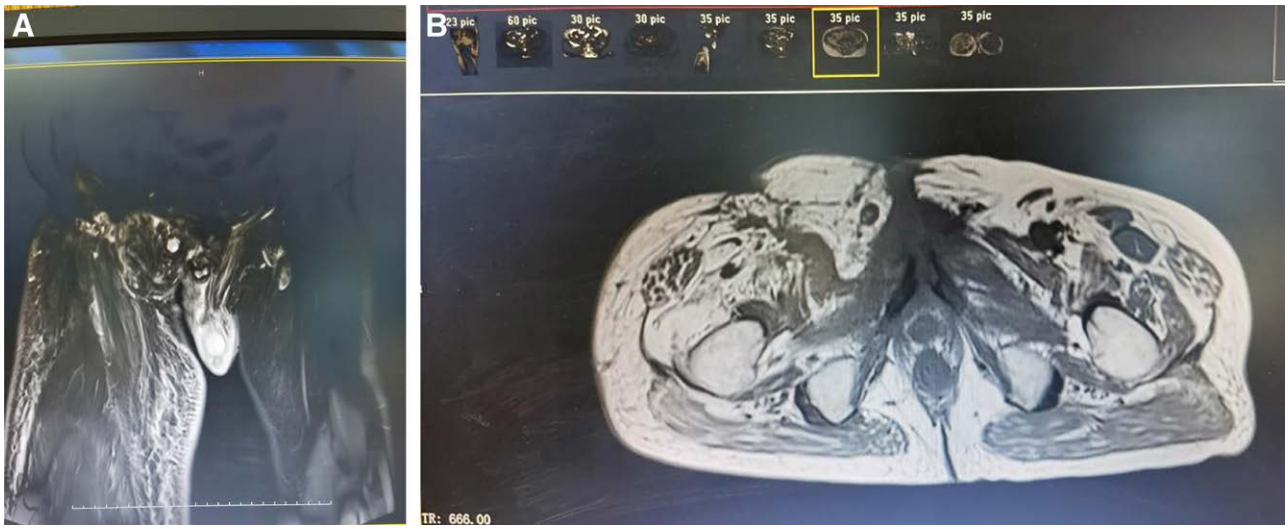

Fig. 4. Magnetic resonance imaging results at 1-year postoperatively revealing the complete filling of the large inguinal cavity by the implanted omentum. A, Coronal magnetic resonance imaging findings of the inguinal surgical site at 1 year postoperative. B, The horizontal magnetic resonance imaging findings of the inguinal surgical site at 1 year postoperative.

omental transplantation, consistent with intact omental function. At 2 hours postinjection, increased lymphatic opacity was evident in both lower extremities, relative to 15 minutes postinjection (Fig. 5).

DISCUSSION

In the present case, we successfully used a vascularized omentum lymphatic transplantation approach to treat a large ulcerative sinus in the groin caused by lymphatic effusion, effectively resolving the chronic lymphatic fistulization experienced by the patient. Local omentum pliability remained after transplantation, consistent with the efficient drainage of local lymphatic fluid and its return to the venous system, unlike the severe edema evident after rectus island flap repair. Lymph node dissection can result in lymphatic fistula formation. To address this potential issue, we applied negative pressure suction to the wound to facilitate effective drainage in combination with the local application of pressure using an elastic bandage.[9] Although this strategy can effectively manage advanced lymphatic fistulas with accompanying lower limb lymphedema and impaired healing, it necessitates indefinite maintenance therapy and can yield significant variability with respect to the quality of patient care. As a result, patients generally experience an impaired quality of life and a high financial burden.

Increasingly advanced microsurgical techniques have led to the emergence of lymphovenous anastomosis as a critical approach for the management of lymphatic fistulas and lymphedema. This approach entails the use of appropriate magnification to carefully align veins and lymphatic vessels such that lymphatic fluid can smoothly drain into the vascular system, reducing pressure within lymphedematous tissues and abrogating patient symptoms.[10] Although this strategy represents an effective means of managing and promoting the healing of wounds associated with lymphatic fistulas, proper lymphovenous anastomosis is strictly dependent on the ability to adequately identify functional and suitable lymphatic vessels using indocyanine green lymphography. Therefore, it is necessary to select appropriate veins with proper dimensions corresponding to lymphatic vessels that exhibit minimal venous return flow. Inappropriate vein selection can contribute to an increase in intraluminal pressure and postoperative reflux of blood into the lymphatic channel, interfering with lymphatic fluid return and exacerbating limb edema and lymphatic fistulization.[7] Multiple lymphovenous anastomoses in different locations and at different levels are required in the affected limbs to ensure the effective diversion of lymphatic flow, thereby alleviating lymphedema. However, this complex operative approach can cause additional damage to the already dysfunctional lymphatic system.[11] In the present case, the groin wound had already been subjected to a prolonged period of rupture and was associated with a large cavity exhibiting lymphatic fluid leakage from multiple sites. A previous single lymphovenous anastomosis procedure failed to achieve positive outcomes in this patient.

VLNT is the most recent surgical approach for treating lymphedema of the extremities, although the precise mechanisms through which it exerts its benefits remain unclear. In the basic VLNT approach, transplanted lymph nodes in a transferred tissue flap are believed to serve as lymphatic pumps that facilitate lymphatic fluid drainage. An arteriovenous pressure gradient attracts lymph node effusion to the recipient site from the mesenchyma, whereupon this fluid can enter the vasculature by transferring lymphatic vessels surrounding the lymph nodes in the transferred flap.[12,13] Cheng et al[6] injected indocyanine green at the margins of inguinal lymph node flaps and lymph node-free abdominal flaps in rats and humans, respectively. Although venous fluorescence was evident in the VLNT group, consistent with lymphatic fluid drainage into the pedicle vein of the flap, no such fluorescence was evident in the lymph node-free abdominal flaps, providing experimental and

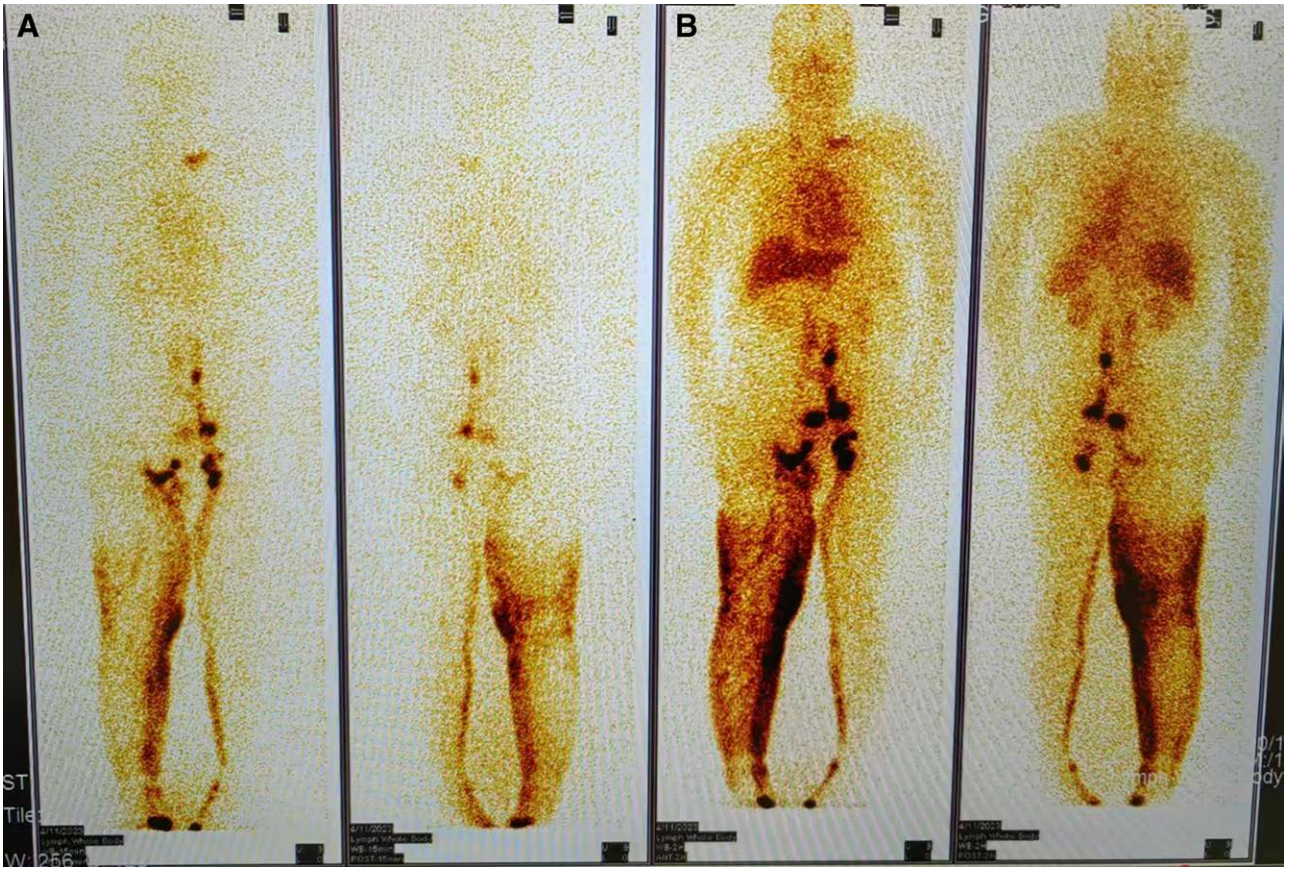

Fig. 5. Lymphatic nuclide imaging of bilateral lower extremities was performed 1 year postoperatively. Lymphatic nuclide imaging of bilateral lower extremities was performed 1 year postoperatively via the interdigital subcutaneous injection of ^{99}mTc-DX 1.5 mCi/0.2 mL in each foot. A, At 15 minutes postinjection, normal lymphatic flow was evident on the healthy side, with clearly visible lymphatic vessels, left inguinal lymph nodes, and the iliolumbar lymph trunk. In contrast, lymphatic return remained impaired in the lower right extremity, with high radiotracer concentrations being evident in the right groin at the site of omental transplantation, consistent with intact omental function. B, At 2 hours postinjection, increased lymphatic opacity was evident in both lower extremities relative to the 15-minute time point.

clinical support for this functional mechanism. Another proposed mechanism through which VLNT exerts its benefits involves the induction of lymphatic recanalization as a result of the stimulation of lymphangiogenesis. The expression of vascular endothelial growth factor C in vascularized lymph node flaps can promote new lymphatic vessel development and stimulate the ingrowth of existing or newly developed lymphatic vessels into the VLNT network. At present, this mechanism has only been documented in animal model systems.[14,15] Despite some uncertainties regarding the exact mechanisms through which VLNT functions, this approach has been demonstrated to be a safe and effective means of treating lymphatic exudation and lymphedema. The vascularized lymph node flaps commonly used for this procedure include the inguinal flap, submaxillary flap, supraclavicular flap, thoracic lymph node flap, and abdominal omental lymph node flap,[16,17] providing an effective means of alleviating lymphedema that develops as a result of trauma, tumor resection, lymph dissection, or other etiological factors. Although effective, this procedure is subject to several potential limitations, including scarring and iatrogenic lymphedema of the donor site. After lymphatic dissection in the groin region, a subset of patients with lymphedema exhibit severe localized fibrosis and impaired wound healing for which surgery is often ineffective. Two leading causes of treatment failure are infection and lymphatic leakage. Loose deep tissues in the inguinal region can also contribute to the formation of deep cavities, which can further hamper treatment efforts.

To overcome these challenges, in the present case, we sought to leverage a more advantageous vascularized lymph node flap. The vascularized omental lymph node flap is a valuable resource because it contains lymph nodes and a unique omental-associated lymphoid tissue reticular structure.[18] This structure facilitates the entry of lymphatic fluid into the lymphatic collection system via the pedicle and is absent in other vascularized lymph node flaps. In animal model studies, the omentum has been reported to play a role in promoting lymphangiogenesis. Vascular endothelial growth factor concentrations in the rat omentum exceed those in other tissues and organs, including adipose tissues, by at least 10-fold. The omentum is highly immunologically active and can police local tissue compartments for pathogens.[19] It normally functions as a protective barrier to prevent infections and inflammation. As such, this omental free tissue flap represents an ideal autologous tissue resource

compared with myocutaneous flaps. Using omental tissue to fill deep infected cavities, it is possible to simultaneously seal the area while combatting local infections and remediating local lymphatic flow, thereby contributing to appropriate wound healing. However, there are some limitations to the use of vascularized omental lymph node flaps. The absence of skin covering the transplanted flap requires further measures to ensure flap survival. If the blood flow between the transplanted flap and the recipient site is not effectively established, this may also contribute to impaired skin graft viability. Access to the abdominal cavity to obtain the donor omentum also has the potential to damage nearby structures and contribute to the development of intestinal adhesions or obstructions. To minimize the risk of complications and maximize donor site preservation, a laparoscopic approach was used to excise the omentum in this patient.

During the 1-year follow-up visit, the patient exhibited no evidence of recurrent wound rupture or lymphatic leakage, and significant improvements in lower limb edema and condition of the overlying skin were observed. The omental lymph node flap, as a type of vascularized lymph node flap, possesses an abundant network of blood vessels and lymphatic circulation. This not only enables it to effectively control complex infections and combat the occurrence and progression of tumors but also endows it with a robust capacity for exudate absorption and inguinal wound filling. Consequently, it emerges as an optimal choice for managing refractory wounds in the inguinal region.

CONCLUSIONS

In summary, vascularized omental lymphatic transplantation was successfully performed in this case as a means of repairing chronic and refractory groin wounds and lymphedema through a single surgical procedure. Thus, this approach represents a promising alternative for the future management of similarly affected patients.

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DISCLOSURES

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