How I do it: Radical debulking of lower extremity end-stage lymphedema

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ABSTRACT

Debulking procedures have been a last-resort therapy for end-stage lymphedema for more than a century. Multiple techniques have been described, and the approach as a whole has fallen in and out of favor as providers have tried to maximize quality of life outcomes. We describe our technique for radical debulking of the lower extremity for the treatment of severe end-stage lymphedema. (J Vasc Surg Cases Innov Tech 2023;9:101238.)

Keywords: Debulking; Elephantiasis; Lower extremity; Lymphedema; Radical

The first surgical management of lymphedema was described by Sir Richard Henry Havelock Charles,[1] who published his series of 140 consecutive cases for the treatment of scrotal filariasis. This work was followed by a book chapter titled, "Elephantiasis scroti," published in 1912, in which he also briefly described the management of lower extremity lymphedema.[1] The eponymous, "Charles procedure" was later attributed to him in the mid-20th century by Sir Archibald McIndoe.[2] This ablative procedure includes debridement of all involved skin and subcutaneous tissue down to the investing fascia, followed by split-thickness skin grafting.[1,3]

Since then, numerous other procedures have been explored, with varied success. Investigators such as Sistrunk,[4] Homans,[5] and Thompson[6,7] contributed their respective procedures, now also eponymous, using tissue rearrangement for the coverage of surgical wounds.[8,9] The Charles procedure, too, has undergone various modifications, most notably, delaying the subcutaneous dissection and/or grafting as part of a staged approach.[5,10]

In the present day, suction-assisted lipectomy and liposuction have joined direct excisional techniques in the broader category of reductive and ablative surgical approaches. Alternatively, physiologic methods such as lymphatic—lymphatic bypass, lymphovenous bypass, lymphaticovenular anastomosis, vascularized lymph node transfer, and vascularized omental flap transfer are increasing in popularity.[5,11-15] It should be noted, however, that these physiologic techniques are contraindicated in the setting of late-stage lymphedema and/or extensive tissue fibrosis, necessitating a more radical approach for these more severely afflicted individuals.[16-18]

The increasing incidence of morbid obesity has exacerbated the problem of lymphedema in developed countries. In contrast, historically, this condition was limited to associations with filariasis and lymph node dissection or obstruction.[3,19] In addition to functioning as an independent risk factor for lymphedema after lymph node dissection, morbid obesity is also associated with massive localized lymphedema, a separate condition of large, often pendulous, lymphedema and skin changes affecting the thigh.[20-24]

Contemporary reductive approaches, both with and without modifications, have been described, such as small series reported by van der Walt et al,[25] Sapountzis et al,[26] and Karri et al.[27] These series feature long-term follow-up with no major complications and large-volume limb reduction, with a few patients experiencing minor complications, including intraoperative bleeding, cellulitis, and partial graft loss. Despite retrospective evidence of successful limb size reduction and durable results, opponents of direct excision persist, citing the high morbidity due to wound complications.[28,29] These include, but are not limited to, graft failure, infection, pain, scarring, lymphatic fistulas, worsening edema, and even limb loss.[30,31]

In the present report, we describe our technique for performing radical debulking of the lower extremity for end-stage lymphedema. This procedure has demonstrated particular utility for patients with life-limiting, end-stage lymphedema and is regaining popularity.[17,18] When combined with a multidisciplinary and holistic

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approach to both pre- and postoperative care, patients tolerate the procedure well and recover uneventfully.[17,25,32] Furthermore, they experience immediate dramatic results. The patient-centered outcomes, including daily functionality, mobility, exercise tolerance, and psychosocial factors make this procedure truly liberating and noteworthy.

PREOPERATIVE CONSIDERATIONS

Patient counseling. Our approach begins with thorough preoperative counseling. This counseling occurs during monthly office visits, usually totaling a period of 6 months before scheduling the procedure, and is performed by the attending surgeon because of the unique nature of this procedure. We counsel our patients regarding the high risk of lymphedema recurrence and other risks, including limb loss, bleeding, massive fluid shifts, and the consequences thereof. Patients are warned of a postoperative course that can involve prolonged bed rest, hospitalization, elevation, and the need for multiple procedures. Furthermore, patients are warned of drastic changes in body image and the potential for body dysmorphic-type symptoms, albeit usually self-limiting.

In addition to managing expectations, we attempt to optimize a patient's disease process during the counseling period. Adjunctive therapies used during this period include, but are not limited to, ongoing compression therapy, referral to a lymphedema clinic, and a weight loss program with behavioral modification. Patients are interviewed about family support, reliability of follow-up, and compliance with the interventions. Even at this early stage, this surveillance is performed with the postoperative course in mind, because compliance with compression therapy and drain care are crucial to a patient's recovery.

Patients are selected for surgery in accordance with the results of, and compliance with, the preoperative interventions. All the patients undergoing debulking have stage III disease based on the International Society for Lymphology staging system. The findings of lymphostatic elephantiasis and skin thickening differentiate this process from limb swelling of other etiologies and obesity itself.[33] In addition, patients must not be bedridden, must have an acceptable anesthesia risk, and must have a reasonable expectation of a quality-of-life benefit in terms of ambulation or other functionality. However, no body mass index cutoff is used beyond which surgery is deferred.

Finally, owing to the individualized nature of any single patient's lymphedema distribution and postoperative appearance, it is understood that any clinical images obtained could be somewhat identifiable. We, therefore, obtain written informed consent to both collect and publish clinical photographs, such as those included in the present report.

Fig 1. Esmarch bandage application for preoperative compression. This allows for easier dissection and decreases the amount of fluid lost during surgery.

Before surgery. Patients undergoing radical debulking of end-stage lower extremity lymphedema at our institution are admitted 1 day before surgery. At admission, the patients undergo yet another, even more detailed physical examination, aided by the hospital bed and additional personnel required to lift a heavy extremity. The physical examination includes an inspection of all crevices and skin folds, which are thoroughly washed with a mixture of povidone-iodine and hydrogen peroxide solutions, in addition to the remainder of the leg. The leg is inspected for ulcers, signs of ongoing infection, and any foreign bodies retained in the crevices. If signs of active infection are appreciated, such as abscess or purulent drainage, surgery is postponed until adequate source control has been achieved. The leg is then wrapped tightly with an Esmarch bandage from distally to proximally, encompassing the lymphedematous mass (Fig 1). The bandage is kept in place overnight, evacuating the limb of excess fluid and facilitating easier dissection. Because of the incompressibility of the limb, the risk of ischemia with the Esmarch bandage is minimal. Anticoagulation therapy is initiated with weight-based dosing of low-molecular-weight heparin for the prevention of perioperative deep vein thrombosis. These patients not only have an increased risk of deep vein thrombosis given their body mass index and prolonged

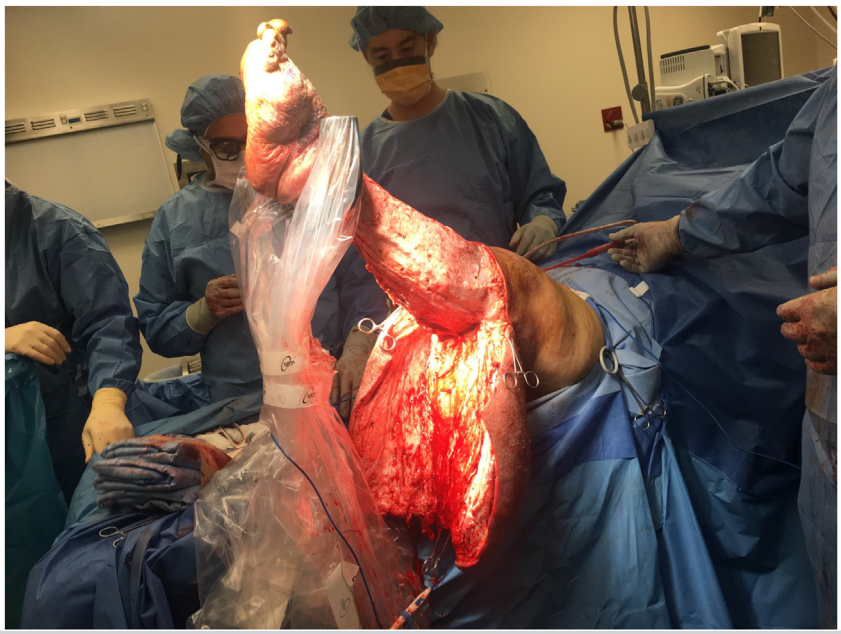

Fig 2. An example of a candy cane stirrup in use.

Fig 3. A and **B,** Woody scales can form over the skin at the most dependent parts of the leg, making incision planning and dissection extremely difficult. Before debulking, the patient underwent a descaling procedure, involving removal of the woody plaques. **C,** A separate case in which calcified fat is noted, most commonly at the level of the ankle. This can be difficult to excise off the fascia and resistant to dissection with both electrocautery and Mayo scissors. **D,** A Ruskin bone cutter is often used to complete both of these dissections.

immobility but would uniquely suffer from impaired venous drainage, given the nature of this procedure.

OPERATIVE TECHNIQUE

As stated, lymphedema of the lower extremity can be confined to the lower leg or the thigh, or can encompass both. In the present report, we focused on the management of end-stage lymphedema of the distal, below-knee lower extremity.

Patient positioning. The patient is placed supine on the operating table. Multiple large-bore intravenous access and radial arterial access are established. Neither locoregional nor epidural nerve blocks are used, because the target tissues are nearly insensate from the chronic inflammation and skin changes. Postoperative pain is managed as needed. General anesthesia is induced, and an endotracheal tube is placed. A Foley catheter is also placed, along with an upper body warm air blanket. Two units of cross-matched packed red blood cells are kept available.

Candy cane stirrups are mounted to the operating table. Often, two could be needed, one on either side, depending on the size of the leg and complexity of the

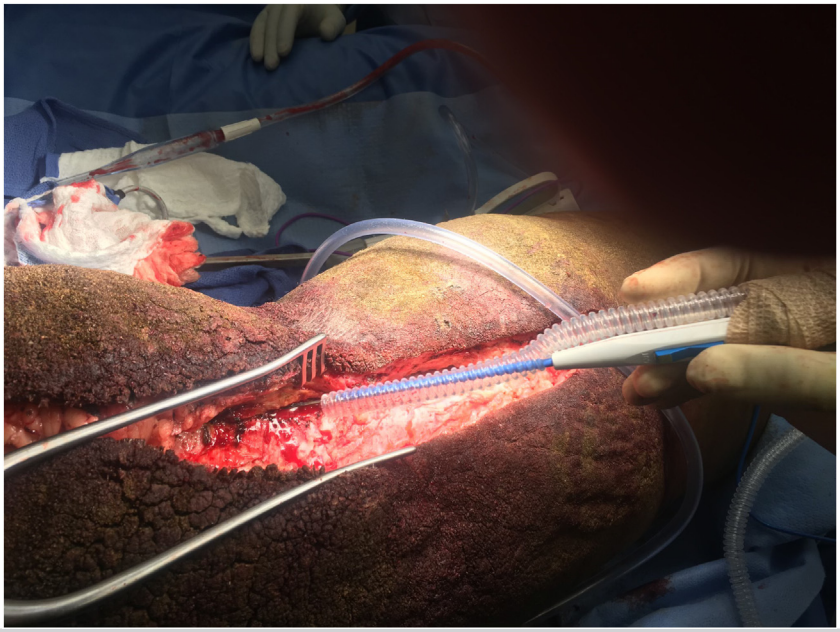

Fig 4. Photograph showing an improvised smoke evacuator. Stock smoke evacuators have proved ineffective at managing the excessive smoke produced by use of electrocautery on thick woody skin.

dissection (Fig 2). A Kerlix (Covidien) gauze roll is added to the feet in some cases to aid in padding and/or suspension of the leg to aid in circumferential dissection later in the operative course. The legs are initially placed flat on the operating table, two electrocautery dispersive electrodes are applied, and both legs undergo a generous circumferential povidone-iodine skin preparation. A wide extremity drape is used. The equipment opened on the field includes the following: a no. 10 blade scalpel, a Ruskin bone cutting forceps, Yankauer suction, two electrocautery pens, a LigaSure Impact (Medtronic) vessel sealer device, and a robust smoke evacuation system. We emphasize that much of the fatty tissue involved should be expected to be calcified, fluid filled, and time consuming to divide with any electrocautery device. As such, our electrocautery settings range from 70 to 100 W in both pure cut and coagulation modes, and the wire cutter is useful for dividing difficult calcified fat (Fig 3). In our experience, handheld electrocautery pens with integrated smoke evacuation tips are often insufficient. We, therefore, prefer to use the large-bore 7/8-in. corrugated smoke evacuation tubing and pass our electrocautery through it (Fig 4). The LigaSure Impact is also well-suited to this application. Its wide jaws can seal vessels and divide fatty tissue in an expeditious manner.

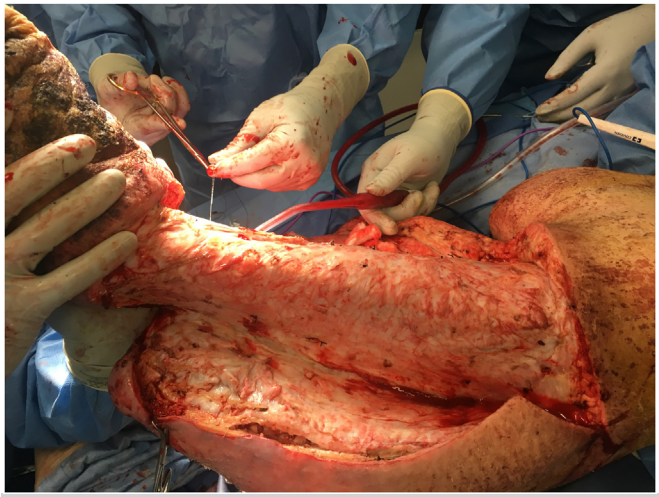

Fig 5. The incision is started at the tibial tuberosity and brought down toward the ankle, with dissection completed in a circumferential fashion. The foot is typically left alone and treated as a separate procedure, if needed. This allows the patient to bear weight and shortens the rehabilitation time.

Radical debulking. An anterior incision is then created, extending from the knee to the ankle and continued down to the level of the anterior tibial fascia. Great care is taken not to violate the fascia. However, in the event of subcutaneous tissue that is adherent to fascia, a small margin of fascia can be taken. This can lead to a degree of muscle bulging and a suboptimal cosmetic result but that is of lower priority than completing the subcutaneous excision. In some cases, a second-stage excision at the same location will be performed if the amount of tissue requiring excision is too great or the operative time becomes too long.

Once the fascia is reached through the anterior incision, dissection is continued along the fascia both medially

Fig 6. To allow for circumferential dissection and improve visibility of the posterior portion of the leg, the foot is propped on a stirrup, and the tissue allowed to hang with gravity.

Fig 7. After complete excision of excess tissue, the specimen could continue to exude fluid. The dry weight of the gross specimen, as measured by the pathology department, is typically a gross underestimation.

and laterally along the circumference of the leg (Fig 5). The proximal extent of this circumferential dissection is distal to the knee joint at the level of the tibial tuberosity. The dissection is intentionally beveled to allow for a gradual transition from the level of the skin superiorly to the depth of the fascia distally. This avoids the knee joint and prevents the creation of sharp angles, which would otherwise need to be traversed by future skin grafting. Once an adequate dissection plane has been achieved, the leg can be suspended with the candy cane stirrups already in place. The weight of the (now pendulous) tissue is converted from a hindrance to an aid by serving as its own retraction as it falls away from the fascia (Fig 6).

At the level of the ankle, great care is required. The anterior tibial artery, posterior tibial artery, and Achilles tendon must be identified, and the dissection carried superficially to all three of these structures. Given the extensive nature of the deep dissection at all other levels of the distal lower extremity, the ankle marks an abrupt transition to a more superficial plane and a change in tissue characteristics. Here, the lymphatic tissues will be notably more inflamed, calcified, and adherent to the fascia. Failure to identify these arterial and tendinous critical structures and superficialize the dissection can lead to their injury. It is even more imperative to stay superficial to the fascia at this level, again to avoid injury to applicable arterial, venous, nervous, and ligamentous critical structures.

A patient-specific approach is used to determine the distal resection margin according to the extent of an individual's disease. In cases in which foot involvement is limited, this dissection can be eliminated. In these limited cases, the distal extent of the dissection is the skin fold at which the dorsum of the foot meets the tissues of the anterior shin. This prevents the need for future skin grafts to bridge the ankle joint. In cases in which foot involvement is more pronounced, dissection of the dorsum of the foot is beneficial to minimize swelling of the foot and improve the fit of footwear.

If the foot is debrided, the resection is carried distally to a skin fold just proximal to the metatarsophalangeal joints, below the malleoli medically and laterally, and

Fig 8. A, Preoperative baseline photograph for comparison. **B,** After complete removal of lymphatic tissue, a negative-pressure dressing is applied. Large surface area coverage is used with reinforcement with an Ioban dressing covering the entire leg and ensuring an adequate seal. The dressing is further enforced with an elastic bandage to provide additional compression.

Fig 9. A, The patient undergoes serial debridements, washing, and negative pressure dressing reapplication for residual tissue and presumed bacterial colonization. This patient was found to have a local pseudomonas infection, which was managed as such. **B,** After completing this regimen, the patient achieved our goal of healthy granulation tissue to serve as a recipient site for the skin graft, which will take on a red, beefy appearance when complete.

deep to the level of the extensor digitorum fascia. Lymphedematous feet that are debrided experience the same impressive outcomes as the remainder of the leg in terms of volumetric reduction. Those that are not debrided either remain unchanged or, in some cases, experience increased lymphedematous changes. In

Fig 10. Photograph taken immediately after debulking. The size discrepancy between the two legs can be quite remarkable, leading to a psychological feeling of instability. This patient had difficult standing because he assumed the operated leg would break if he were to allow the leg to bear his full weight.

these cases, the foot can be debrided in a subsequent procedure. No factors have yet been identified to predict which feet will experience such changes.

Once the circumferential dissection is complete, the specimen is placed in a large basin, and hemostasis is achieved. Voluminous fluid losses can be expected from both the specimen and the dissection (Fig 7). Close communication with anesthesia providers throughout the course of the procedure is essential, because these morbidly obese patients are susceptible to massive fluid shifts across a large volume of distribution.

A vacuum-assisted closure (V.A.C.; 3M Co) dressing is applied to all debrided areas. The dressing is applied for both control and measurement of fluid output in the postoperative setting and to aid in the formation of granulation tissue. Because of the large surface area debrided, an Ioban (3M Co) antimicrobial drape is wrapped circumferentially around the leg until an adequate seal is achieved (Fig 8). In our early experience with this procedure, the operative times ranged from 6 to 7 hours, depending on the extent of resection. At present, the operative time is a maximum of 3 hours.

POSTOPERATIVE MANAGEMENT

Wound care. Postoperatively, patients are transferred to the burn intensive care unit where they undergo cardiorespiratory and hemodynamic monitoring and receive comprehensive wound care. Skin flora antimicrobial coverage is continued and narrowed according to any available wound culture results.

Once every other day, the patients are brought to the burn intensive care unit hydrotherapy room for serial debridement and a change of their V.A.C. dressing. The patient undergoes sedation, and the leg is thoroughly washed, scrubbed, again prepared with povidone-iodine solution, and meticulously debrided of any nonviable tissue. The V.A.C. dressing is then reapplied. This process continues until all nonviable tissue has been removed but for a minimum of 1 week.

Throughout this period and also beginning on postoperative day 1, full weightbearing is permitted with the negative pressure dressing in place. Patients are evaluated by the inpatient physical therapy team at this time and receive treatment at least every other day. No mobility restrictions are put in place at this time, and therapy is only limited by patient tolerance. Ambulation is encouraged, often with the assistance of a walker or other support device. Mobility restrictions are only put in place for a period of 3 to 5 days once the extremity has received its split-thickness autografts.

Tissue coverage. The split-thickness skin graft or autograft is used for coverage of the extremity wound created by the debulking. Negative pressure therapy promotes granulation tissue and prepares the wound bed for skin graft reconstruction (Fig 9).

The split-thickness skin graft is usually harvested from the ipsilateral thigh with a dermatome set at 13 one-thousandths of an inch and meshed or expanded to cover a greater surface area of the wound. Gentamicin ointment-impregnated gauze is placed on the skin graft for topical antibiotic coverage and to prevent desiccation. Negative pressure therapy is then reapplied over the dressing and skin graft for 3 to 5 days, with immobilization to decrease edema and increase angiogenesis. Duoderm (Convatec Inc) and elastic wrap dressings are placed on the thigh donor sites. Marcaine and bupivacaine subcutaneous injections and lateral femoral

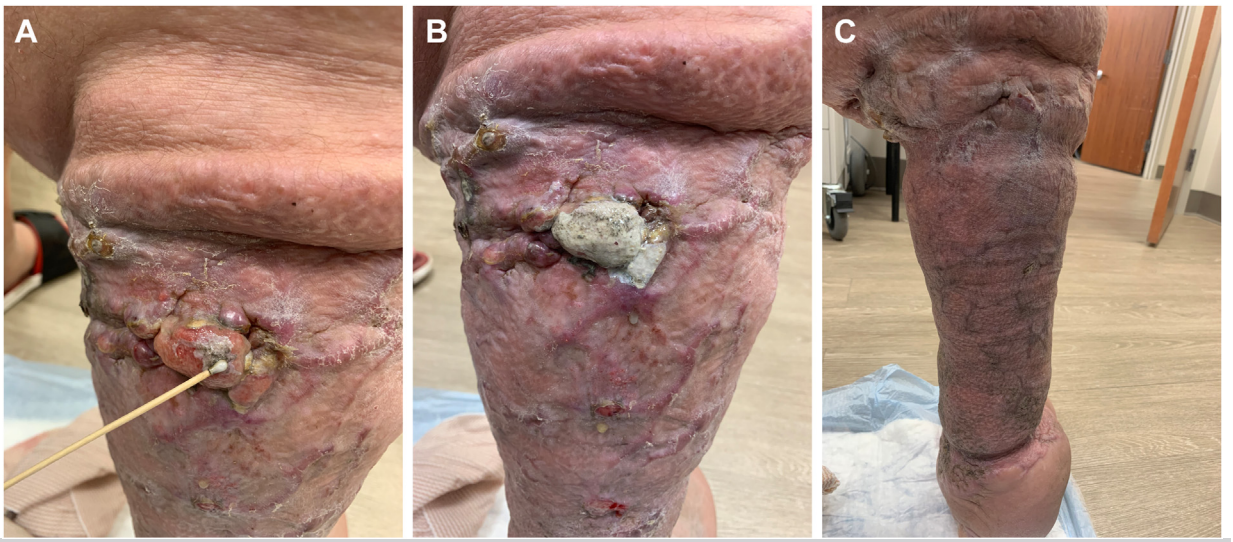

Fig 11. A and **B,** Hypertrophic granulation tissue can occur postoperatively, most often in the setting of noncompliance with compression therapy at the wound edges. This is easily managed in an office-based setting using silver nitrate applicators. **C,** Even large tissue growths can be managed successfully in as few as 4 weeks.

Fig 12. A, Preoperative photograph of a patient before bilateral debulking procedures of the lower extremities. **B,** The surgical outcome was excellent, and the patient's quality of life was markedly improved, with no recurrence 4.5 years later.

cutaneous nerve blocks and femoral nerve blocks are used to decrease donor site pain.

After 3 to 5 days of immobility to aid in graft take, the patients are again evaluated by physical therapy before discharge to a rehabilitation facility. Ambulation and weightbearing are often difficult initially because of patient perceptions that the operated leg cannot hold weight owing to the discrepancy in size, especially if the contralateral leg is involved (Fig 10).

Rehabilitation and follow-up. The initial follow-up examination occurs 1 week after discharge, followed by every 4 weeks for 6 months and then every 6 months indefinitely. Patients are strongly encouraged to comply with compression therapy, typically, three-layer elastic wrap dressings. Because of the unique nature of this procedure, preoperative patient selection, and the paucity of providers who perform these procedures, we have found compliance and follow-up to be excellent. Additionally, with compression therapy and close follow-up, we have found our positive outcomes to be durable.

Minor wound complications are common, particularly at the wound edges. One of the more prevalent of these

issues is hypertrophic granulation tissue. The management for these growths is straightforward during follow-up office appointments (Fig 11). In all, complete wound healing will be achieved by 1 month postoperatively. At this time, the wounds will be clean and dry with no ongoing exudate and no need for further dressing changes.

To date, we have performed 42 radical debulking procedures of the distal lower extremity alone, not including procedures involving the thigh or abdomen. Of these, we have observed a 100% rate of successful limb size reduction with no major complications or recurrence of lymphedema during our 8-year experience.

CONCLUSIONS

End-stage lymphedema is an increasingly common problem in the West that requires a multidisciplinary team of vascular surgeons, surgeons, and wound care nurses to achieve optimal surgical outcomes. With meticulous debridement, followed by negative pressure wound therapy, infection is mitigated. Postoperatively, persistence and further debridement leaves only granulation tissue for excellent graft take. Close follow-up, patient selection, and compliance can limit recurrence and provide excellent results (Fig 12). We hope that our standardized approach encourages hesitant providers to care for these complex patients.

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