variables come into play such as the season (warm or cool), salt intake, weight loss or gain, or level of exertion the day the measurements were taken. While limb volume is important to document, the patient's preoperative and postoperative compression regimen should be recorded, as well as their weight. Because limb volume is a moving target, if a patient has a physiologic procedure, additional outcome measurements are required for credibility. Patient-reported outcomes using a questionnaire such as the ULL-27 become useful when objective outcomes are limited in nature.[78,79] Postoperative lymphoscintigraphy, IGL, and MRL are all complementary assessments, and more recently histologic study allowed us to gain insights into outcomes on a cellular level.[51]

## CONCLUSION

There is a broad array of techniques available to treat lymphedema, and the indications for these procedures are steadily coming to light. Lymphaticovenular anastomosis and vascularized lymph node transfer are among a variety of procedures that offer promise for many patients who suffer greatly from a disease frequently orphaned by the medical community. Undoubtedly, the practice of lymphatic surgery will look significantly different 5–10 years from now. These incremental insights are small steps in the right direction, where future multidisciplinary collaboration will move this field forward.

## Expert Commentaries

**David W. Chang, MD, FACS**

*I would like to congratulate the authors on this very well-written chapter on surgical treatment of lymphedema. Lymphedema is a chronic, debilitating condition that causes physical and psychological morbidity. Unfortunately, no definitive treatment for lymphedema currently exists. Physiologic methods, such as vascularized lymph node transfer or lymphovenous bypass, attempt to restore functional lymphatic drainage.*

*The advances in microsurgery, and more recently supermicrosurgery, have had a major effect on the evolution of these physiologic procedures, which have gained popularity to help reduce the severity of lymphedema. One recent technologic advance is the use of indocyanine green fluorescence lymphangiography to map lymphatic vessels. Indocyanine green fluorescence lymphangiography enables surgeons to locate and make incisions precisely over functional lymphatic vessels for the lymphovenous bypass, significantly improving the outcomes of lymphovenous bypass surgeries.*

*Autologous, or vascularized lymph node transfer aims to bring vascularized tissue and healthy lymph nodes into sites affected by lymphedema. One theory is that lymphangiogenesis occurs via growth factors produced by the transplanted lymph nodes and thereby bridge lymphatic pathways. Another theory proposed is that vascularized lymph node transfer acts as a lymphatic pump. However, one main concern with harvesting lymph nodes is a possibility of causing donor site lymphedema. The use of preoperative lymphoscintigraphy combined with the use of intraoperative gamma probe to detect and preserve "sentinel" lymph nodes can help minimize secondary lymphedema from harvesting of lymph nodes.*

*Currently, there is no cure for lymphedema. Worldwide interest in using microsurgical procedures to treat lymphedema is gaining momentum. However, there is no consensus on the indications for which procedure to perform, when to intervene, or how to comparatively grade outcomes. We need further research and better understanding of lymphatic anatomy and lymphedema pathophysiology. In addition, more prospective and controlled studies are needed to objectively evaluate the outcomes of various treatment methods.*

**Ming-Huei Cheng, MD, MBA, FACS**

*This chapter by Joseph Dayan, Jaume Masia, and Isao Koshima provides a thoughtful and extensive overview of anatomy and physiology, diagnostic tools, surgical indications and techniques relevant to lymphedema. The authors detail reverse lymphatic mapping for lymph node flap harvest, lymphovenous anastomosis (LVA), and vascularized lymph node (VLN) flap transfer using three donor site options.*

*The LVA was introduced by Yamada in 1969 before being modified and popularized by Koshima, more recently. Many surgeons would agree that it is most effective for early treatment of breast cancer–related upper limb lymphedema. LVA is performed by anastomosing residual functional lymphatic collecting ducts to subdermal veins with the assistance of indocyanine green fluorescence lymphography, specialized microscopes capable of ×40 magnification, and supermicrosurgical methods. The surgical technique of LVA requires practice with a slow learning curve. Improvements in postoperative monitoring and long-term follow-up after LVA warrant further investigation.*

*In addition to superficial groin lymph node basins, submental, supraclavicular, thoracic (axillary), and intra-abdominal (omental) lymph nodes have been described in microvascular transfer. Because outcomes measures are not standardized, large multicenter series do not exist. Establishment of a gold standard outcomes measure that allows comparisons between different methods is a major aim of lymphedema research. The concept of reverse lymphatic mapping for decreasing the donor site morbidity is an important contribution in VLN flap transfer. Improvements at donor and recipient sites alike will promote acceptance of VLN flap transfer among surgeons and patients. At the time of writing, the role of reverse lymphatic mapping lacks adequate data to support its favorable influence on the risk:benefit balance for VLN flap transfer.*

*The location of optimal VLN flap recipient sites remains controversial. Recent data are in support of distal recipient sites, such as the wrist, versus proximal sites such as the elbow. For example, patients who have undergone VLN flap transfer to distal recipient sites do not require compression garments postoperatively. One disadvantage of the distal recipient site is the bulky and often unsightly flap, though this can be revised postoperatively.*

*Goals of treatment of lymphedema include (1) decreased limb firmness, swelling, and volume; (2) decreased cellulitis and infection rates; (3) increased quality of life, eliminating the need for compression garments; (4) minimal donor site morbidity; and (5) improved appearance of the recipient site. Prioritization of these goals, selection of available surgical options, and donor and recipient site choice are surgeon-dependent and should be evaluated on a case-by-case basis.*

## CASE 8.1 Lower Extremity Lymphedema Treated with Lymph Node Transfer

A young woman presented with secondary lower extremity lymphedema of the right leg following trauma. She had a history of cellulitis, despite compliance with compression garments. Work-up involved lymphoscintigraphy, which demonstrated diffuse dermal backflow in the calf with some groin lymph node drainage. MRA demonstrated a fluid component of approximately 50% contribution to the limb volume with fat hypertrophy. The patient underwent a thoracodorsal artery-based lymph node transfer to the right calf (Fig. 8.22A). Postoperatively, she had a reduced need for compression (grade 2 garment down from a grade 4 garment), as well as a reduced limb volume (Fig. 8.22B,C). Postoperative lymphoscintigraphy at 1 year demonstrated uptake of the transferred lymph nodes to the calf (Fig. 8.22D). Postoperative MRA demonstrated reduced fluid component of her lymphedema, while the fat hypertrophy component remained unchanged (Fig. 8.22E,F). MRA also demonstrated a total of seven viable vascularized lymph nodes at the recipient site (Fig. 8.22G).

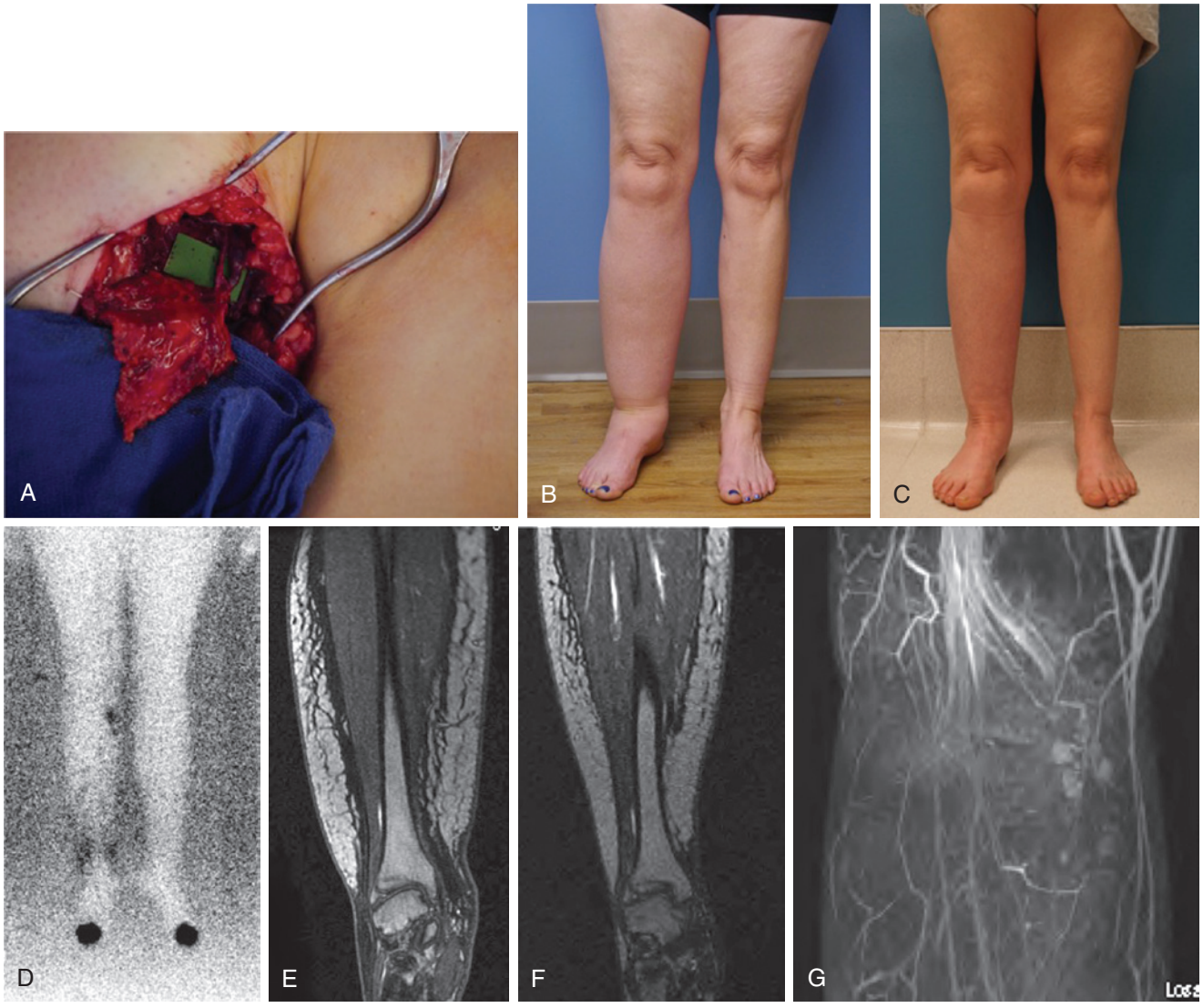


**Figure 8.22** Lower extremity lymphedema treated with lymph node transfer. (A) Thoracodorsal artery-based lymph node flap to the medial sural vessels. (B) Preoperative photograph of the right lower extremity lymphedema. (C) A 1-year postoperatively following lymph node transfer to the calf. (D) Postoperative lymphoscintigraphy at 1 year, demonstrating uptake of technetium into transferred lymph nodes in the calf. (E) Preoperative MRA demonstrating approximately 50/50 contribution of fluid and fat hypertrophy to limb volume. (F) Postoperative MRA at 1 year, demonstrating reduction in fluid component but persistence of fat hypertrophy. (G) Postoperative MRA demonstrating seven viable lymph nodes at the calf recipient site.