Accepted Manuscript online: 2026-09-28 Article published online: 2026-10-08

Thieme

Journal of Reconstructive Microsurgery

Review Article

Assessment and Management of Extremity Lymphedema: Position Paper of WSRM

Peter Neligan[1], Dimitrios Dionyssiou[2], David Woosuk Chang[3], Jaume Masia Ayala[4], Akitatsu Hayashi[5], Johnson Chia-Shen Yang[6,7], Dhruv Singhal[8], Joon Pio Hong[9]

Affiliation addresses are listed at the end of the article.

CC BY NC ND

ABSTRACT

This position paper was developed by the World Society for Reconstructive Microsurgery Task Force on Lymphedema to establish consensus-based recommendations for the management of extremity lymphedema. The document addresses key domains of care, including assessment, treatment strategies, surgical interventions, and postoperative management, with the goal of providing practical and adaptable guidance applicable across diverse clinical settings.

Effective management of extremity lymphedema requires a structured and standardized approach encompassing comprehensive evaluation, individualized treatment, and long-term follow-up. Initial assessment should include a detailed history and physical examination, supplemented by standardized limb circumference measurements and clinical photography to ensure objective and reproducible documentation. Imaging modalities, such as lymphoscintigraphy and indocyanine green (ICG) fluorescent lymphography, are essential for accurate disease characterization and surgical planning. Preoperative optimization with conservative therapy and compression remains a critical step prior to intervention. Surgical management should be tailored to disease severity and patient-specific factors, incorporating physiologic procedures—including lymphaticovenous anastomosis (LVA), vascularized lymph node transfer (VLNT), and lymphaticovenular anastomosis (LNVA)—as well as excisional techniques such as liposuction and direct excision when indicated. Postoperative care should include regular noninvasive assessments at 3-month intervals and annual imaging to monitor outcomes. Long-term follow-up, extending up to 5 years, is recommended to ensure sustained clinical improvement and to guide ongoing management.

Keywords extremity lymphedema, consensus paper on lymphedema, lymphatic surgery

received April 26, 2026 | **accepted after revision** September 14, 2026 | **accepted manuscript online** September 28, 2026 | **article published online** 2026

Bibliography J Reconstr Microsurg **DOI** 10.1055/a-2968-4476 **Art ID** JRM-26-04-0118

© 2026. The Author(s). Thieme Medical Publishers, Inc., 333 Seventh Avenue, 18th Floor, New York, NY 10001, USA

Correspondence Joon Pio Hong, MD, PhD, MMM, Department of Plastic Surgery, Asan Medical Center, University of Ulsan, 88 Olympicro Songpagu, 138736 Seoul, Korea (The Republic of), Email: joonphong@amc.seoul.kr

Introduction

Lymphedema requires a comprehensive and multidisciplinary approach to diagnosis, treatment, and long-term management.[1–6] The effective care of lymphedema patients hinges on thorough assessment, appropriate diagnostic investigations, and tailored surgical interventions complemented by diligent postoperative care. Here we provide an overview of the lymphedema assessment process, compare different imaging techniques used in diagnosis, explain preoperative optimization for lymphedema surgery, discuss postoperative management and follow-up care, and provide an overview of different surgical procedures for lymphedema as assessed by the World Society for Reconstructive Microsurgery (WSRM) Lymphedema Task Force.

Material and Methods

This position paper was generated from Zoom conference calls between members of a WSRM Task Force on Lymphedema, formed under the presidency of Dr. J.P. Hong and under the direction of Dr. Peter Neligan. The brief of the task force was to generate recommendations on the management of extremity lymphedema for WSRM membership. Four Zoom meetings were held and during each one, the taskforce addressed a specific aspect of lymphedema care. The headings of the discussions were Assessment, Management, Procedures, and Postoperative care. This paper is a synthesis of these discussions. Being cognizant of the fact that resource access varies among WSRM membership, the committee categorized these recommendations, thus, deciding that some of the recommendations were de rigueur or mandatory while others are useful if available.

© 2026. The Author(s).

Minimal Recommendations for Extremity Lymphedema Surgery

- Detailed history and physical examination
- Standardized limb circumference measurements
- Standardized photography
- Imaging studies:
  - Lymphoscintigraphy
  - Fluorescent lymphography (ICG)

Preoperative optimization with therapy/compression
Physiologic procedures: Lymphaticovenous anastomosis (LVA), vascularized lymph node transfer (VLNT), lymphaticovenular anastomosis (LNVA).
Excisional procedures: Liposuction, direct excision
Postoperative care:

- Noninvasive assessment every 3 months
- Imaging every year

Total follow-up up to 5 years

History and Physical Examination

The initial assessment of a lymphedema patient is crucial and involves a detailed history and physical examination. The patient's history should meticulously document the onset and progression of swelling, including etiology such as history of surgery, lymph node dissection, radiation therapy, chemotherapy, trauma, or infection. Primary versus secondary lymphedema can generally be diagnosed based on the history. A family history is therefore important. Also, all known risk factors for secondary lymphedema should be explored.

In the physical examination, the presence of pitting edema and a history of cellulitis episodes should be carefully noted. The condition of the skin should be noted. The extremity should then be examined in detail.

Limb Circumference Measurements

A standardized approach to limb circumference measurement is essential. Ideally, limb circumference converted to volume using formulas like the Brorson formula is desirable for quantifying the swelling and monitoring treatment response.[7] Other methods like CT or MRI volumetric measurements are useful if available.[8,9] Perometry is accurate and easy to perform, though not widely available.[10] It is critical to compare the affected limb with the contralateral, unaffected limb and to record additional body weight changes.

Quality of life assessment, using validated questionnaires or specific questioning, is equally important to understand the functional and psychosocial impact of the condition.[11–13] Standardized photography, with specific protocols for both upper and lower limbs (including consistent background color, foot placement templates, and "birds' eye" views), provides valuable visual documentation of the lymphedema. Such standardized protocols should be instituted.

Investigations

Diagnostic investigations play a crucial role in confirming the diagnosis, ruling out other conditions, and guiding treatment decisions. Lymphoscintigraphy is recommended in all cases where the diagnosis is uncertain and can also serve as a baseline in all patients. Magnetic resonance lymphangiography (MRL) is a useful investigation that may be offered if available.[14,15] SPECT CT can also be helpful, although its availability may be limited.[16] Indocyanine green (ICG) lymphangiography is considered necessary to document the status of superficial lymphatics and should ideally be available at the initial assessment.[1] Ultrasound is a valuable investigation.[17–19] While ultra-high definition ultrasound can give great detail, it is expensive and not widely available.[20] However, regular ultrasound with probes up to 20 MHz are very useful and readily accessible.[17] Bioimpedance analysis (BIA) is another tool that can be used to analyze the water content of the extremity and document postoperative improvements.[21,22] Bioimpedance works on the principle that the amount of opposition to the flow of an electrical current (impedance) through the body is inversely proportional to the volume of fluid in the tissue. In lymphedema tissue impedance decreases as a low electrical current passes through the tissues.

These investigations are recommended every 6 months for the first year, and then annually. Each imaging technique offers unique advantages. Lymphoscintigraphy provides functional information about lymphatic drainage, while MRL offers detailed anatomical visualization. ICG lymphangiography allows real-time assessment of superficial lymphatic flow. Ultrasound can identify both lymphatics and veins and has expanded the indications for lymphovenous bypass.

Preoperative Management

Preoperative optimization is paramount to maximizing the success of surgical interventions. Patients should optimize their condition through preoperative therapy and demonstrate compliance with conservative management, including garment use and bandaging. Ideally, patients should attend the provider's therapist, but if distance is a barrier, they should see a local therapist and document their adherence to therapy. Addressing modifiable risk factors, such as obesity, is crucial.[23–25] While an ideal BMI is desirable, patients should be encouraged to lose weight. Glucagon-like peptide 1 (GLP-1) agonists and bariatric surgery may be considered for weight management in appropriate candidates. In patients with questionable venous status or a history of deep vein thrombosis (DVT), a vascular consult is recommended to optimize venous function.

Treatment

Surgical options for lymphedema have expanded in recent years, offering tailored approaches based on the patient's individual needs. There is a clear trend toward interdisciplinary surgical evaluation program including lymphatic surgery, certified lymphedema therapy, and lymphatic medicine.[6] Lymphovenous anastomosis (LVA) is indicated when imaging (MRL, ICG, ultrasound) identifies linear lymphatic vessels with the caveat that linear vessels that connect with a lymph node basin be avoided.[26,27] If the patency of the extremity lymphatic vessels is observed leading to a regional lymph node especially in the groin region, a lymph node to vein anastomosis (LNVA) can be considered.[28] If no linear lymphatics are identified, VLNT is an option, with the donor site selected based on surgeon and patient preference. Reverse

© 2026. The Author(s).

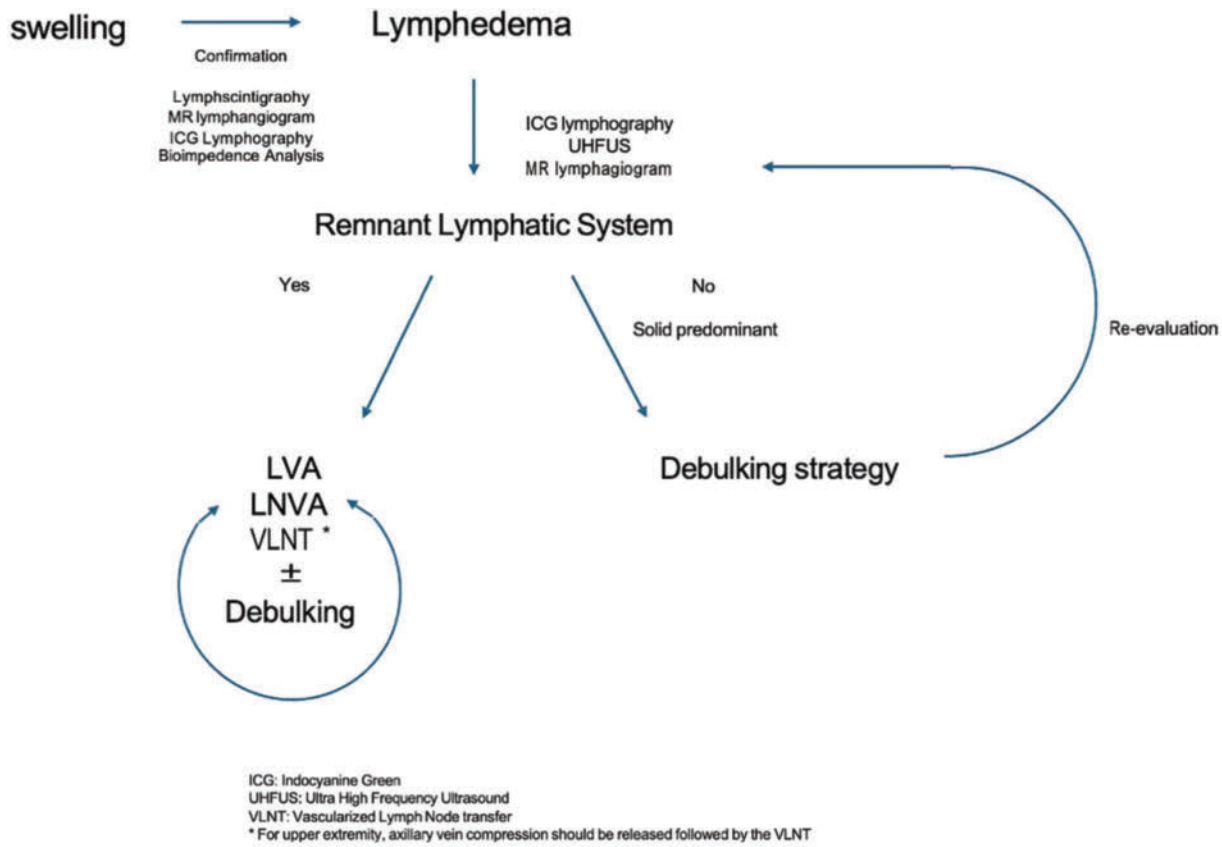


Fig. 1 Algorithm of approach.

lymphatic mapping or SPECT-CT imaging techniques are recommended to minimize donor site complications.[29,30] A combination of LVA and VLNT may be appropriate in some patients. In cases of axillary vein compression, axillary clearance combined with VLNT may be considered, unless lymphoscintigraphy shows evidence of lymphatic function in the axilla. Decompression of the axillary vein has been shown to play an important role in these patients.[31] Biobridge is a nanofibrillar matrix that has been shown to encourage lymphangiogenesis.[32,33] Biobridge procedures, either from distal to proximal functioning nodes or VLNT with a bridge to functioning normal-sided nodes, can be utilized, particularly in the lower limb.

In addition to the physiological surgery mentioned above, nonphysiological surgery such as liposuction or debulking procedures can be considered. While the physiologic surgery aims to reduce the fluid content of the extremity, the nonphysiologic surgery aims to remove the fibrotic component of the lymphedema.[34,35] Once the tissue turns fibrotic, physiologic surgery has limited effect and often in advanced stages of lymphedema, both approaches are often required together and can be completed in stages. **Fig. 1** depicts the overall algorithm of surgical approach.

Postoperative Management

Postoperative management is critical for maintaining the benefits of surgical interventions. Following bypass surgery compression therapy is universally employed, although protocols vary, ranging from immediate compression to initial bandaging followed by compression garments after a few days or weeks. Some surgeons use bandaging postoperatively rather than compression garments because of the fear of disrupting superficial LVA surgery with the shear associated with putting on compression garments. In LNT with collagen scaffolds, compression with bandages for 2 weeks is typically used. Daily bandage removal, manual lymphatic drainage onto the collagen scaffolds, and reapplication of bandages are essential to promote lymphatic drainage. Weaning from compression is a goal, but patients should be informed that it may not always be possible. Some patients can reduce compression intensity, while others may need compression indefinitely. The decision to wean is based on clinical response, as evidenced by patient's symptoms, circumference/volume measurements, bioimpedance measurements, and ICG imaging.

Follow-up Protocol

Follow-up care is essential for long-term monitoring and management. Noninvasive follow-up, including circumference/volume measurements and bioimpedance, should be routinely performed at 3 months. Invasive imaging, such as ICG, MR/CT (for estimating fluid vs. solid components), and lymphoscintigraphy, should be performed yearly. Follow-up including standardized photodocumentation should continue for up to 5 years.

Conclusion

The management of lymphedema requires a holistic approach encompassing thorough patient assessment, appropriate

© 2026. The Author(s).

Table 1 Minimal recommendations for extremity lymphedema surgery

• Detailed history and physical examination
• Standardized limb circumference measurements
• Standardized photography
• Imaging studies:
◦ Lymphoscintigraphy
◦ Fluorescent lymphography (ICG)
• Preoperative optimization with therapy/compression
• Physiologic procedures: LVA, VLNT, LNVA
• Excisional procedures: Liposuction, direct excision
• Postoperative care:
◦ Noninvasive assessment every 3 months
◦ Imaging every year
• Total follow-up up to 5 years

Abbreviations: LNVA, lymphaticovenular anastomosis; LVA, lymphaticovenous anastomosis; VLNT, vascularized lymph node transfer.

diagnostic investigations, individualized surgical interventions, and diligent postoperative care (**Table 1**). By adhering to these principles, clinicians can optimize outcomes and improve the quality of life for individuals living with lymphedema. The role of ongoing research and technological advancements will continue to refine these approaches and offer new hope for patients with this challenging condition.

Author Affiliations

1 Department of Plastic and Reconstructive Surgery, University of Washington, Seattle, Washington, United States

2 Department of Plastic Surgery, Medical School, Faculty of Health Sciences, Aristotle University of Thessaloniki, Thessaloniki, Greece

3 Department of Plastic and Reconstructive Surgery, University of Chicago, Chicago, Illinois, United States

4 Department of Plastic Surgery, Hospital de la Santa Creu i Sant Pau, Universitat Autònoma de Barcelona, Barcelona, Spain

5 Department of Breast Center, Lymphedema Center, Kameda Medical Center, Kamogawa, Chiba, Japan

6 Division of Plastic and Reconstructive Surgery, Department of Surgery, Lymphedema Center, Kaohsiung Chang Gung Memorial Hospital, Kaohsiung, Taiwan

7 College of Medicine, Chang Gung University, Taoyuan, Taiwan

8 Division of Plastic and Reconstructive Surgery, Department of Plastic Surgery, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, United States

9 Department of Plastic Surgery, Asan Medical Center, University of Ulsan, Seoul, Korea (The Republic of)

Statements and Additional Information

Conflict of Interest The authors declare that they have no conflict of interest.

© 2026. The Author(s) This is an open access article published by Thieme under the terms of the Creative Commons Attribution-NonDerivative-NonCommercial-License, permitting copying and reproduction so long as the original work is given appropriate credit. Contents may not be used for commercial purposes, or adapted, remixed, transformed or built upon. (https://creativecommons.org/licenses/by-nc-nd/4.0/).

References

1 Kung TA, Champaneria MC, Maki JH, Neligan PC. Current concepts in the surgical management of lymphedema. Plast Reconstr Surg 2017;139(04):1003e–1013e

2 Masià J, Al Sakkaf AM, Hong JP, et al. Barcelona consensus paper on reconstructive lymphedema surgery: a Delphi study. Plast Reconstr Surg 2026;157(01):193–203

3 Fanning JE, Aly MAI, Chang DW, et al. A proposed minimum standard set of outcome measures for lymphatic surgery: results of a modified Delphi process from the society of lymphatic surgery leadership. Plast Reconstr Surg 2025

4 Kwon JG, Kim Y, Jang MY, et al. The quality of life after lymphaticovenous anastomosis in 118 lower limb lymphedema patients. Arch Plast Surg 2023;50 (05):514–522

5 Erickson VS, Pearson ML, Ganz PA, Adams J, Kahn KL. Arm edema in breast cancer patients. J Natl Cancer Inst 2001;93(02):96–111

6 Fanning JE, Friedman R, Shillue K, et al. Surgical treatment of lymphedema at LE&RN comprehensive centers of excellence. J Reconstr Microsurg 2026;42 (01):1–6

7 Brorson H, Höijer P. Standardised measurements used to order compression garments can be used to calculate arm volumes to evaluate lymphoedema treatment. J Plast Surg Hand Surg 2012;46(06):410–415

8 Mitsumori LM, McDonald ES, Neligan PC, Maki JH. Peripheral magnetic resonance lymphangiography: techniques and applications. Tech Vasc Interv Radiol 2016;19 (04):262–272

9 Chromy A, Zalud L, Dobsak P, Suskevic I, Mrkvicova V. Limb volume measurements: comparison of accuracy and decisive parameters of the most used present methods. Springerplus 2015;4:707

10 Batista BN, Baiocchi JMT, Campanholi LL, Bergmann A, Duprat JP. Agreement between perometry and sequential arm circumference measurements in objective determination of arm volume. J Reconstr Microsurg 2018;34(01):29–34

11 Pusic AL, Cemal Y, Albornoz C, et al. Quality of life among breast cancer patients with lymphedema: a systematic review of patient-reported outcome instruments and outcomes. J Cancer Surviv 2013;7(01):83–92

12 Monticone M, Ferriero G, Keeley V, et al. Lymphedema quality of life questionnaire (LYMQOL): cross-cultural adaptation and validation in Italian women with upper limb lymphedema after breast cancer. Disabil Rehabil 2022;44(15):4075–4080

13 Keeley V. Quality of life assessment tools in chronic oedema. Br J Community Nurs 2008;13(10):S22–S27

14 Mitsumori LM, McDonald ES, Wilson GJ, et al. MR lymphangiography: how I do it. . J Magn Reson Imaging 2015;42;(06):1465–1477

15 Maki JH, Neligan PC, Briller N, Mitsumori LM, Wilson GJ. Dark blood magnetic resonance lymphangiography using dual-agent relaxivity contrast (DARC-MRL): a novel method combining gadolinium and iron contrast agents. Curr Probl Diagn Radiol 2016;45(03):174–179

16 Iimura T, Fukushima Y, Kumita S, Ogawa R, Hyakusoku H. Estimating lymphodynamic conditions and lymphovenous anastomosis efficacy using (99m)Tc-phytate lymphoscintigraphy with SPECT-CT in patients with lower-limb lymphedema. Plast Reconstr Surg Glob Open 2015;3(05):e404

17 Hayashi A, Hayashi N, Yoshimatsu H, Yamamoto T. Effective and efficient lymphaticovenular anastomosis using preoperative ultrasound detection technique of lymphatic vessels in lower extremity lymphedema. J Surg Oncol 2018;117(02):290–298

18 Alshomer F, Jeong HH, Pak CJ, Suh HP, Hong JP. Identifying functional lymph nodes in lower extremity lymphedema patients: the role of high-frequency ultrasound. J Reconstr Microsurg 2024;40(07):527–534

19 Kim HB, Jung SS, Cho MJ, et al. Comparative analysis of preoperative high frequency color Doppler ultrasound versus MR lymphangiography versus ICG lymphography of lymphatic vessels in lymphovenous anastomosis. J Reconstr Microsurg 2023;39(02):92–101

20 Cho MJ, Chratian S, Visconti G, Hayashi A, Hong JP, Chao AH. Ultra high-frequency ultrasound in lymphatic surgery: the next frontier. Expert Rev Med Devices 2024;21(11):995–998

21 Warren AG, Janz BA, Slavin SA, Borud LJ. The use of bioimpedance analysis to evaluate lymphedema. Ann Plast Surg 2007;58(05):541–543

22 Kim MG, Son WC, Kwon JG, et al. Clinical utility of bioimpedance analysis for upper limb lymphedema with surgical treatment. Lymphat Res Biol 2025;23 (01):39–45

23 Jammallo LS, Miller CL, Singer M, et al. Impact of body mass index and weight fluctuation on lymphedema risk in patients treated for breast cancer. Breast Cancer Res Treat 2013;142(01):59–67

24 Burian EA, Rungby J, Karlsmark T, et al. The impact of obesity on chronic oedema/lymphoedema of the leg—an international multicenter cross-sectional study (LIMPRINT). Int J Obes (Lond) 2024;48(09):1238–1247

25 Maclellan RA, Greene AK. Abstract 71: obesity-induced lymphedema: presentation, diagnosis, and management. Plast Reconstr Surg 2014;133(03): 82–83

26 Chang DW, Suami H, Skoracki R. A prospective analysis of 100 consecutive lymphovenous bypass cases for treatment of extremity lymphedema. Plast Reconstr Surg 2013;132(05):1305–1314

27 Koshima I, Nanba Y, Tsutsui T, Takahashi Y, Itoh S. Long-term follow-up after lymphaticovenular anastomosis for lymphedema in the leg. J Reconstr Microsurg 2003;19(04):209–215

28 Pak CS, Suh HP, Kwon JG, Cho MJ, Hong JP. Lymph node to vein anastomosis (LNVA) for lower extremity lymphedema. J Plast Reconstr Aesthet Surg 2021;74 (09):2059–2067

29 Dayan JH, Dayan E, Smith ML. Reverse lymphatic mapping: a new technique for maximizing safety in vascularized lymph node transfer. Plast Reconstr Surg 2015;135(01):277–285

30 Dionyssiou D, Demiri E, Sarafis A, Goula CO, Tsimponis A, Arsos G. Functional lymphatic reconstruction with the "Selected Lymph Node" technique guided by a SPECT-CT lymphoscintigraphy. J Surg Oncol 2019;120(06):911–918

31 Jeong HH, Yoon IA, Al-Shomer FM, et al. Decompression of axillary vein: an essential adjunct for advanced lymphedema. Plast Reconstr Surg 2024;154 (01):218–226

32 Bae AS, Loening AM, Carrion K, et al. Lymphatic regeneration visualized on magnetic resonance imaging after placement of aligned nanofibrillar collagen scaffolds for treatment of lymphedema. Ann Plast Surg 2025;95 (03):286–291

33 Nguyen DH, Zhou A, Posternak V, Rochlin DH. Nanofibrillar collagen scaffold enhances edema reduction and formation of new lymphatic collectors after lymphedema surgery. Plast Reconstr Surg 2021;148(06):1382–1393

34 Brorson H. Liposuction in lymphedema treatment. J Reconstr Microsurg 2016;32 (01):56–65

35 Karlsson T, Hoffner M, Ohlin K, Svensson B, Brorson H. Complete reduction of leg lymphedema after liposuction: a 5-year prospective study in 67 patients without recurrence. Plast Reconstr Surg Glob Open 2023;11(12):e5429

© 2026. The Author(s).