

Contemporary concepts in Lymphatic Surgery

A little old and a whole lot new

By Dr. James Kennedy

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Why is lymphedema so hard to diagnose?

Let's talk about lymphedema imaging technologies

By Savannah Paetzel and Dr. Melissa Aldrich

Charts & Tables

Table 1

	 Comprehensive Center of Excellence	 Network of Excellence	 Referral Network of Excellence	 LD Surgery Center of Excellence	 LD Conservative Care Center of Excellence
DIAGNOSIS					
Cancer-related or non-cancer related LE	✓	✓ or affiliate referral	✓ or local referral		
Lipedema	✓	✓ or affiliate referral	✓ or local referral		
Congenital vascular anomalies including lymphatic malformations, discernment between vascular, lymphatic, and combined disorders	✓	✓ or affiliate referral	✓ or local referral		
Systemic lymphatic disorders (pleural effusions, pulmonary, chylothorax, protein-losing enteropathy, lymphangiectasias, genital)	✓	✓ or affiliate referral	✓ or local referral		
Protein-losing enteropathy	✓	✓ or affiliate referral	✓ or local referral		
Lymphangiectasias	✓	✓ or affiliate referral	✓ or local referral		
Lymphaticovenous disease	✓	✓ or affiliate referral	✓ or local referral		
Pediatric lymphatics expertise	✓	✓ or affiliate referral	✓ or local referral		
Filariasis, podoconiosis	✓	✓ or affiliate referral	✓ or local referral		
Gorham's disease, lymphangiomatosis	✓	✓ or affiliate referral	✓ or local referral		
Collaboration with practitioner(s) or facility capable of accurate LD diagnosis				✓	✓
IMAGING					
Radionuclide lymphoscintigraphy	✓	✓ or affiliate referral	✓ or local referral		
Near-infrared fluorescence lymphography	✓	✓ or affiliate referral	✓ or local referral	✓	
Direct contrast lymphography (for cisterna chyli and thoracic duct visualization)	✓	✓ or affiliate referral	✓ or local referral		
Venography	✓	✓ or affiliate referral	✓ or local referral		
Venous and lymphatic ultrasonography	✓	✓ or affiliate referral	✓ or local referral		
MRI imaging	✓	✓ or affiliate referral	✓ or local referral		
MR lymphography	✓	✓ or affiliate referral	✓ or local referral		

Table 2

Type of methodology	Benefits	Limitations	Particular applications	Resolution	Needs contrast injection?	Invasiveness/Safety	Cost (for the patient)
Lymphoscintigraphy	Visualizes deeper vessels/nodes, dermal backflow	<p>Long integration times prevent imaging of real-time lymphatic contractile function</p> <p>Spatial resolution limits visualization of fine (shallow) lymphatic vasculature</p> <p>Difficult to evaluate lymph vessels in the lateral region</p> <p>Cannot always achieve a definite diagnosis of LE with this tool alone</p>	<p>Evaluating LE</p> <p>Assessing lymphatic drainage</p> <p>Diagnosis of primary intestinal lymphangiectasia, identification of sentinel lymph nodes in cancers</p>	Low - does not allow clear identification of vessel/ lymph node location		<p>Safe but uncomfortable (contrast TECHNETIUM-99m stings after injection)</p> <p>Contrast half-life of 6 hrs - clears relatively quickly</p> <p>Exposure to low levels of radiation</p>	Estimated national average according to MDsave: \$1,543
ICG lymphography	Repeated imaging is safe/possible - flexible for	Images of deeper lymphatics (1 cm)	Real-time observation of lymph vessels during surgery	Relatively high resolution images up		<p>Safety of ICG has been shown in clinical practice</p> <p>Contrast stays in lymphatics 4-6 hrs, goes into blood circulation, half-life in blood of 3 mins, clears through liver/bile</p>	Commercially available but not routinely used to diagnose LE; primarily used to find viable

	<p>longitudinal studies; high sensitivity</p> <p>Rapid imaging</p> <p>Detects retained fluid w/o background noise, increasing accuracy</p> <p>Observation from multiple directions is possible</p> <p>Visualizes dermal backflow</p>	<p>depth) not as well-focused</p>	<p>Phenotyping LD (for determining cancer patient susceptibility to postsurgical lymphatic complications)</p> <p>Detecting early signs of lymphatic dysfunction in breast cancer survivors</p> <p>Assessing the extent/ progression of LE in patients</p>	<p>to 10 millimeters into soft tissues</p> <p>Higher than lymphoscintigraphy</p> <p>Lower than MRI/MRL</p>			<p>lymphatic vessels prior to reparative lymphatic microsurgeries</p> <p>Estimated cost unavailable; coincidental with microsurgery assessment</p>
<p>Near-infrared lymphatic fluorescence (NIRF-LI) imaging</p>	<p>Repeated imaging is safe/possible - flexible for longitudinal studies; high sensitivity</p> <p>Rapid imaging</p> <p>Detects retained fluid w/o background noise, increasing accuracy</p> <p>Observation from multiple directions is possible</p> <p>Visualizes dermal backflow</p>	<p>Images of deeper lymphatics (3-4 cm depth) not as well-focused</p>	<p>Real-time observation of lymph vessels during surgery</p> <p>Phenotyping LD (for determining cancer patient susceptibility to postsurgical lymphatic complications)</p> <p>Demonstrating the effectiveness of lymphatic therapy in increasing lymph flow</p> <p>Detecting early signs of lymphatic dysfunction in</p>	<p>Relatively high resolution images up to 3-4 centimeters into soft tissues</p> <p>Higher than lymphoscintigraphy</p> <p>Lower than MRI/MRL</p>		<p>Safety of ICG been shown in clinical practice</p> <p>Contrast stays in lymphatics 4-6 hrs, goes into blood circulation, half-life in blood of 3 mins, clears through liver/bile</p>	<p>Not yet commercially available.</p> <p>Estimated cost once available: approx. \$1500 per session</p>

	<p>Lymphatic pumping is observable for several hours</p> <p>Can visualize lymph nodes to 3-4 centimeters in depth</p>		<p>breast cancer survivors</p> <p>Assessing the extent/ progression of LE in patients</p>			
Magnetic resonance imaging (MRI)	<p>Observes secondary changes in the skin and tissue</p> <p>Superior sensitivity to CT & lymphoscintigraphy</p> <p>Can detect subcutaneous fat to detect LE</p>	<p>Real-time diagnosis cannot be achieved</p> <p>Differentiation of LE from edema is not always possible</p>	<p>Determining the severity of the causative disease in cases of secondary edema, the presence/ absence of disease in cases of primary edema, & the presence of LE</p>	High		<p>Estimated national average according to MDSave: \$889</p> <p>Medicare covers approx 60%</p>
PET/CT	<p>Useful for lymph node staging</p>	<p>Inflammation can mimic cancer results in lymph nodes</p> <p>Not specific for LE</p>	<p>Detecting smaller lesions for cancer staging</p> <p>Determining the severity of the causative disease in cases of secondary edema, the presence/ absence of disease in cases of primary edema, & the presence of LE</p>	Low - must be combined with other imaging modalities to clearly define the anatomy	<p>Exposure to low levels of radiation from both PET contrast and CT radiation</p> <p>Tracer could give you an allergic reaction in rare instances</p> <p>Radioactive material stays in body up to 2 days</p>	<p>Estimated national average according to MDSave: \$4537</p>

Lymphangiography		<p>Time-Consuming</p> <p>Doesn't show lymph flow</p> <p>Vessel cannulation is difficult</p>				<p>Invasive</p> <p>Contrast agent used can damage the lymph vessel wall, disturb drainage, or result in a potential fatal oil embolism</p>	<p>Estimated national average according to MDSave: \$196</p>
Magnetic resonance lymphography (MRL)	<p>Visualizes both superficial and deep lymphatic systems</p> <p>Visualizes dermal backflow</p> <p>Takes 1 hr (relatively short)</p>	<p>Small lesions can be missed</p> <p>Image blurs easily</p> <p>Cannot do bilateral imaging -- you need a contralateral limb to compare to</p>	<p>Identifying anatomic/physiological abnormalities associated with lymphatic dysfunction to determine further treatment strategies</p> <p>Imaging the lymphatic system in multiple pathologies</p> <p>Representing the lymphatic vessel anatomy & drainage patterns</p> <p>Studying changes of the lymphatic system</p> <p>Diagnosis & classification of peripheral LE</p>	High		<p>Non-invasive</p> <p><i>Usually</i> uses contrast agent, which can easily enter veins</p>	
Contrast-enhanced	Specificity for	Cannot	Guiding the	High			Estimated national

ultrasound (CEUS)	lymph nodes High contrast sensitivity and signal-to-noise ratio (comparable to PET and SPECT)	show lymphatic pumping	acquisition of fine-needle biopsies	spatial resolution (comparable to MRI or CT and greater than PET or SPECT)			average according to MDsave: \$424
Photoacoustics	Enables higher resolution in deep tissues compared to diffuse optical techniques Provides volumetric depth resolution (unlike NIRF-LI)	Cannot show lymphatic pumping Field-of-view is more limited than intensified CCD camera-based NIRF-LI In advanced LE, you might only see veins or dermal backflow, not lymphatic vessels Only images 3-4 mm in depth	Detecting sentinel lymph nodes deep in tissues May lead to image-guided intervention to mitigate some morbid side-effects of lymph node resection & new research capabilities for treating LE	High spatial and temporal resolution		<i>Can</i> use indocyanine green as contrast agent	Not yet commercially available
SPECT-CT	Reduces image-degrading effects of partial volume	Cannot show lymphatic pumping	Contains all the necessary information for surgery				\$1300-\$3700

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Therapy for lipedema

Incorporating new clinical guidelines

By Guenter Klose

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Editors Note: Following up on our interview with Dr. Tobias Bertsch in our Fall 2020 issue of Pathways, the International Lipedema Consensus Document has been published as a supplement of the Journal of Wound Care. This Consensus paper is now supported from Key opinion leaders from 10 European countries.

You can view the supplement using the following link: https://www.magonlinelibrary.com/pb-assets/JOWC/JWC_Consensus_Lipoedema.pdf

Putting the “self” into self MLD

Yoga basics enhance Manual Lymphatic Drainage self management time

By Lisa McKhann

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Hints and Tips

Compression garments for lymphedema

By Mona Al Onazi and Rachel Wang

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