Magnetic Resonance Lymphangiography (MRL)

10/6/2021
R. Carson Sibley, MD
Stanford Cancer Imaging Training Fellow
Body MR Fellow

Mentors: Andreas Loening, MD, PhD and Shreyas Vasanawala, MD, PhD
Lymphedema

“It’s a very rare disease—it doesn’t have a cure. It doesn’t even have a spokesperson.”
VIRTUAL LYMPHATIC SUMMIT 2021:
The Continuum from Evolving Research to State-of-the-Art Lymphatic Management

NOVEMBER 12th & 13th

A forum for LE&RN’s Centers of Excellence and the lymphatic disease community
The Lymphatic System
Lymphatic System

- 23.1 ml/sec
- 3500 km
- 2,000 ml
Lymphedema

Lymphedema

# Lymphedema Staging

<table>
<thead>
<tr>
<th>Stage</th>
<th>Clinical Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Latent or subclinical condition in which swelling is not yet evident despite impaired lymph transport with subtle changes in tissue fluid or changes in subjective symptoms. It may exist months or years before overt edema occurs.</td>
</tr>
<tr>
<td>I</td>
<td>Early accumulation of fluid relatively high in protein content, which subsides with limb elevation. Pitting may occur.</td>
</tr>
<tr>
<td>II</td>
<td>Limb elevation alone rarely reduces tissue swelling, and pitting is common.</td>
</tr>
<tr>
<td>III</td>
<td>Lymphostatic elephantiasis in which pitting can be absent and trophic skin changes, such as acanthosis, fat deposits, and warty overgrowths, develop.</td>
</tr>
</tbody>
</table>

*Other classifications/authors use arabic numerals for these stages: 0, 1, 2, 3.*
Why Lymphedema at a SCIT Seminar
Why Lymphedema in Cancer Imaging

Breast Cancer
- 3-5 million patients
Why Lymphedema in Cancer Imaging

- Gynecological Cancer
  - 10-49% with pelvic lymph node dissection and radiation
Why Lymphedema in Cancer Imaging

• Melanoma
  • Up to 83% after inguinal node dissection
  • 15% after axillary dissection.
Why Lymphedema in Cancer Imaging

- Head and Neck Cancer
  - > 50% patients with neck dissection
Why Lymphedema in Cancer Imaging

• Prostate Cancer
  • 21% after radical prostatectomy
Cellulitis in Lymphedema
Treatment

Complete Decongestive Therapy [https://www.lymphcareusa.com/professional/therapy-solutions-complete-decongestive-therapy.html](https://www.lymphcareusa.com/professional/therapy-solutions-complete-decongestive-therapy.html)  
Accessed: 2020-07-04
Vascularized Lymph Node Transfer

BioBridge

https://www.hopkinsmedicine.org/plastic_reconstructive_surgery/services-appts/lymphedema.html
Lymphatic Venous Anastomosis
Lymphoscintigraphy

CiteCheng, Ming-Huei MD, MBA, FACS; Pappalardo, Marco MD, MSc⁺; Lin, Chieh MD, PhD⁺; Kuo, Chang-Fu MD, PhD⁸; Lin, Chia-Yu MSc⁺; Chung, Kevin C. MD, MS⁴ Validity of the Novel Taiwan Lymphoscintigraphy Staging and Correlation of Cheng Lymphedema Grading for Unilateral Extremity Lymphedema, Annals of Surgery: September 2018 - Volume 268 - Issue 3 - p 513-525 doi: 10.1097/SLA.0000000000002917
Lymphoscintigraphy

Lymphoscintigraphy for the diagnosis of extremity lymphedema: Current controversies regarding protocol, interpretation, and clinical application, Marco Pappalardo, Ming-Huei Cheng Journal of Surgical Oncology, 121, 1, 6 2019
How do surgeons use this?
Indocyanine Green Lymphography
Indocyanine Green Lymphography
MR Lymphangiography
MR Lymphangiography

MR Lymphangiography

Dermal Backflow

Contrast Agents

- Gadolinium containing agents small molecular sizes (~1nm, ~1kD)
  - Diffuse into the veins
Lymphatics or Veins?
Dual Agent Relaxivity Contrast - MRL
LVA/VLNT (Control) vs. LVA/VLNT + BioBridge

Dual Agent Relaxivity Contrast - MRL

• Advantages:
  • Suppress vascular signal

• Disadvantages:
  • Long echo times -> long acquisition time
  • Two contrast agents
  • Diffusion into vascular system
  • Black Box warning for ferumoxytol
  • Infiltration risk
  • Gadolinium Deposition
# Select Lymphatic Contrast Agents

<table>
<thead>
<tr>
<th>Contrast Agent</th>
<th>Modality</th>
<th>Molecular Size</th>
<th>FDA Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur Colloid</td>
<td>NM</td>
<td>~5-200 nm depending on filtration</td>
<td>yes</td>
</tr>
<tr>
<td>Multihance</td>
<td>MR</td>
<td>~1 nm</td>
<td>yes</td>
</tr>
<tr>
<td>Indocyanine Green</td>
<td>NIRF</td>
<td>Binds albumin</td>
<td>Yes</td>
</tr>
<tr>
<td>Ablavar</td>
<td>MR</td>
<td>Binds albumin</td>
<td>Yes (but discontinued)</td>
</tr>
<tr>
<td>Magtrace</td>
<td>MR (SPIO)</td>
<td>~60 nm</td>
<td>Yes</td>
</tr>
<tr>
<td>Lymphoseek</td>
<td>NM</td>
<td>Binds CD206 on macrophages and dendritic cells in lymph nodes</td>
<td>Yes</td>
</tr>
<tr>
<td>Ferumoxytol</td>
<td>MR (USPIO)</td>
<td>17-30 nm</td>
<td>Yes</td>
</tr>
</tbody>
</table>
THANK YOU!

Program Directors: Bruce Daniel, MD and Sandy Napel, PhD
Mentors: Andreas Loening, MD, PhD, Shreyas Vasanawala, MD, PhD, Dung Nguyen MD, Stan Rockson, MD
3D Lab