

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 Vasanaawala, MD, PhD



Stanford
MEDICINE

Stanford Cancer Imaging Training Program
SCIT

Lymphedema



*"It's a very rare disease—it doesn't have a cure.
It doesn't even have a spokesperson."*



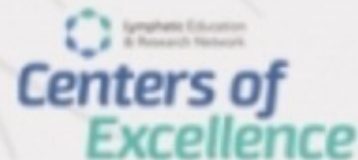
Earn 9 CME Credits Online!

VIRTUAL LYMPHATIC SUMMIT 2021:

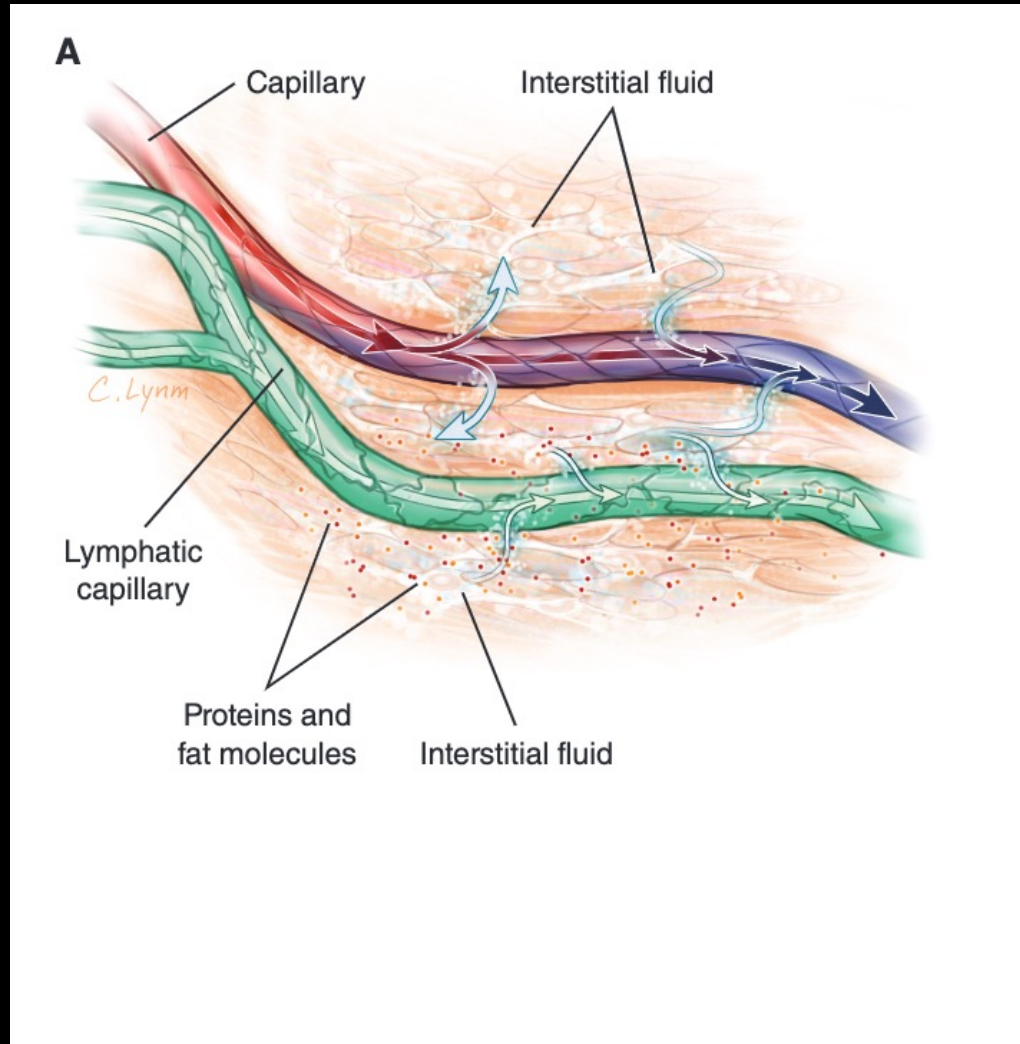
The Continuum from Evolving Research to State-of-the-Art Lymphatic Management

NOVEMBER 12th & 13th

A forum for LE&RN's Centers of Excellence and
the lymphatic disease community



The Lymphatic System

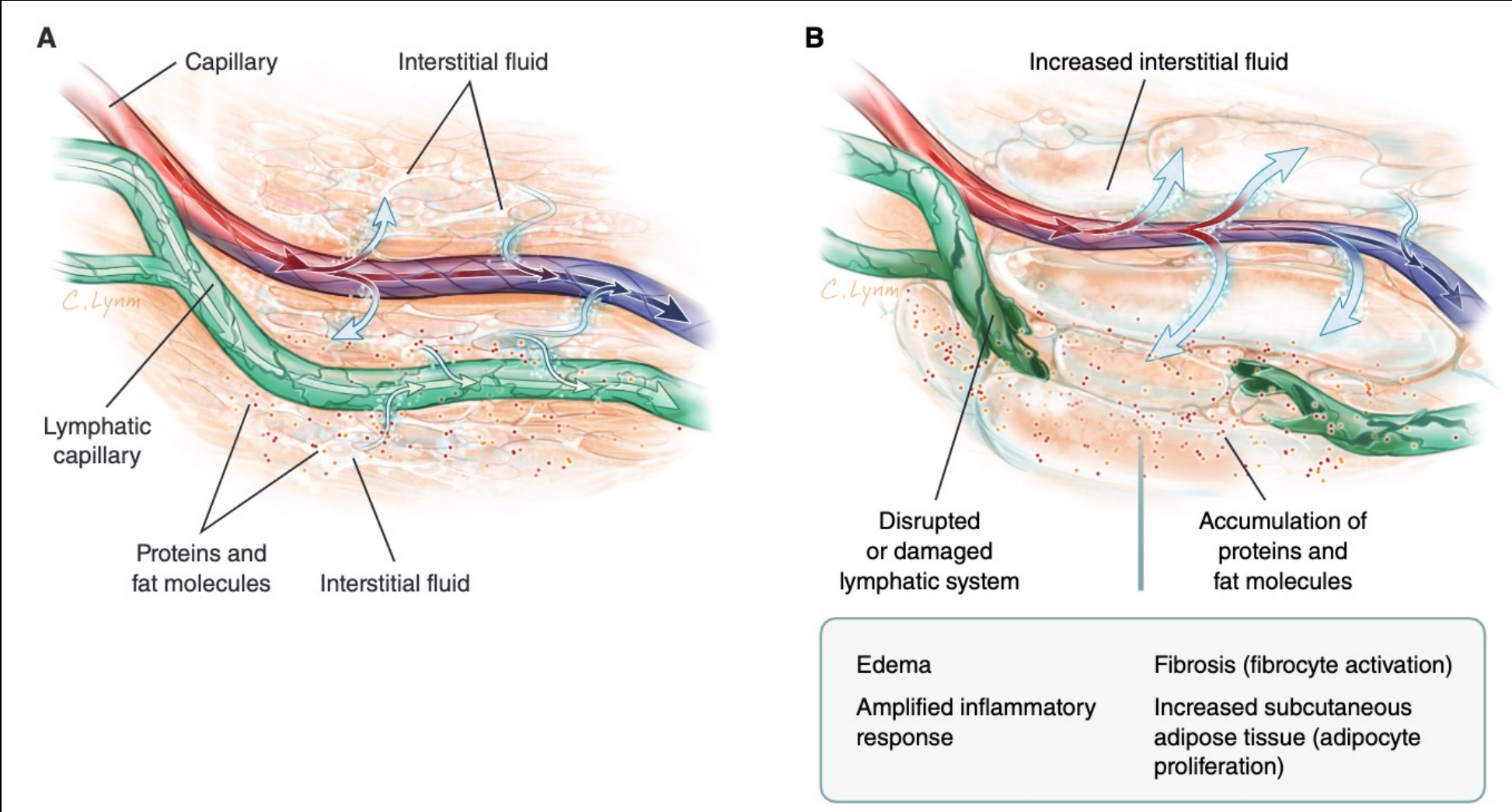


Lymphatic System

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

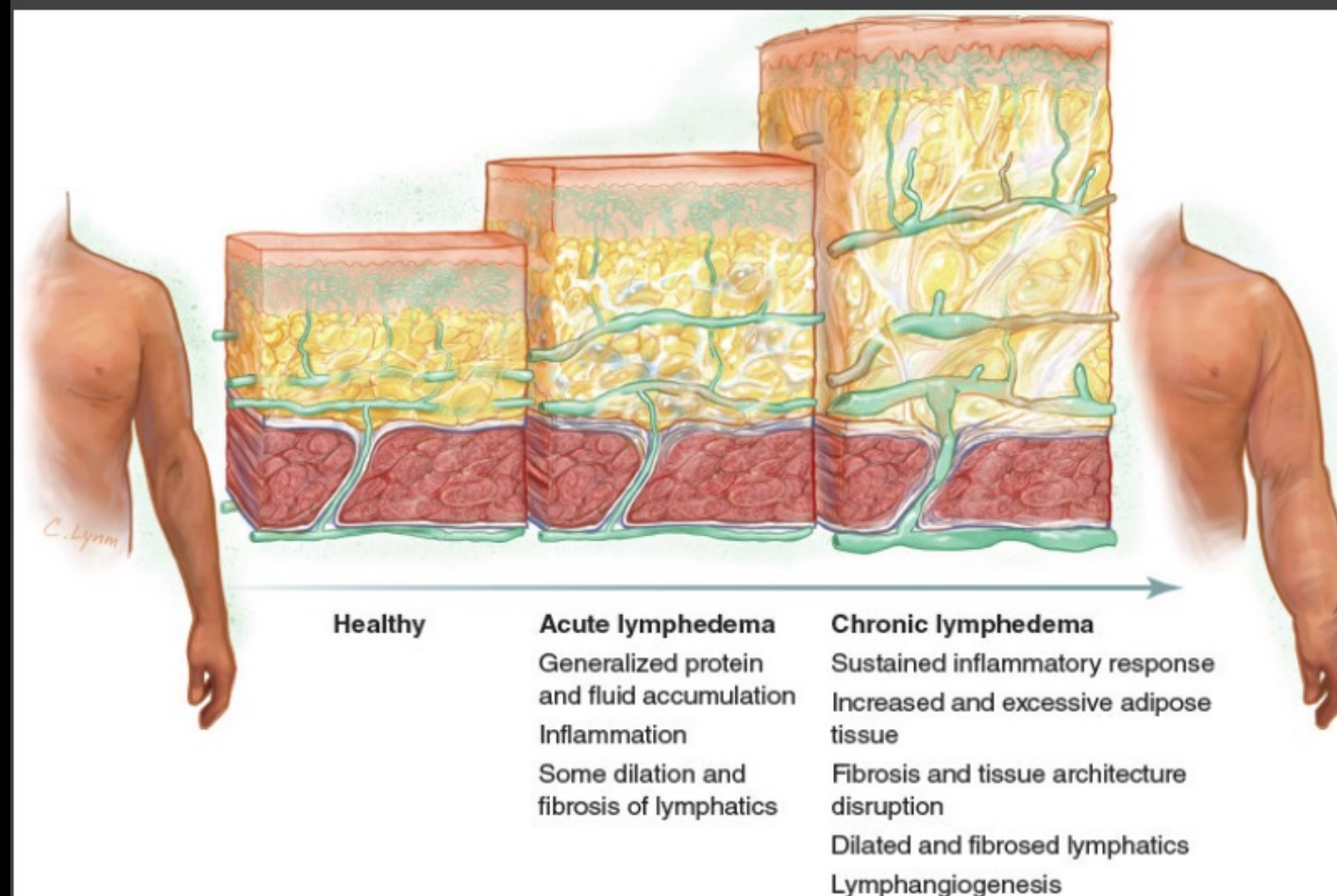


Lymphedema



Neligan PC, Masia J, Piller NB. *Lymphedema : Complete Medical and Surgical Management*. NEW YORK: Thieme; 2015.
<http://search.ebscohost.com.foyer.swmed.edu/login.aspx?direct=true&db=nlebk&AN=1696430&site=eds-live&scope=site>. Accessed May 29, 2020.

Lymphedema



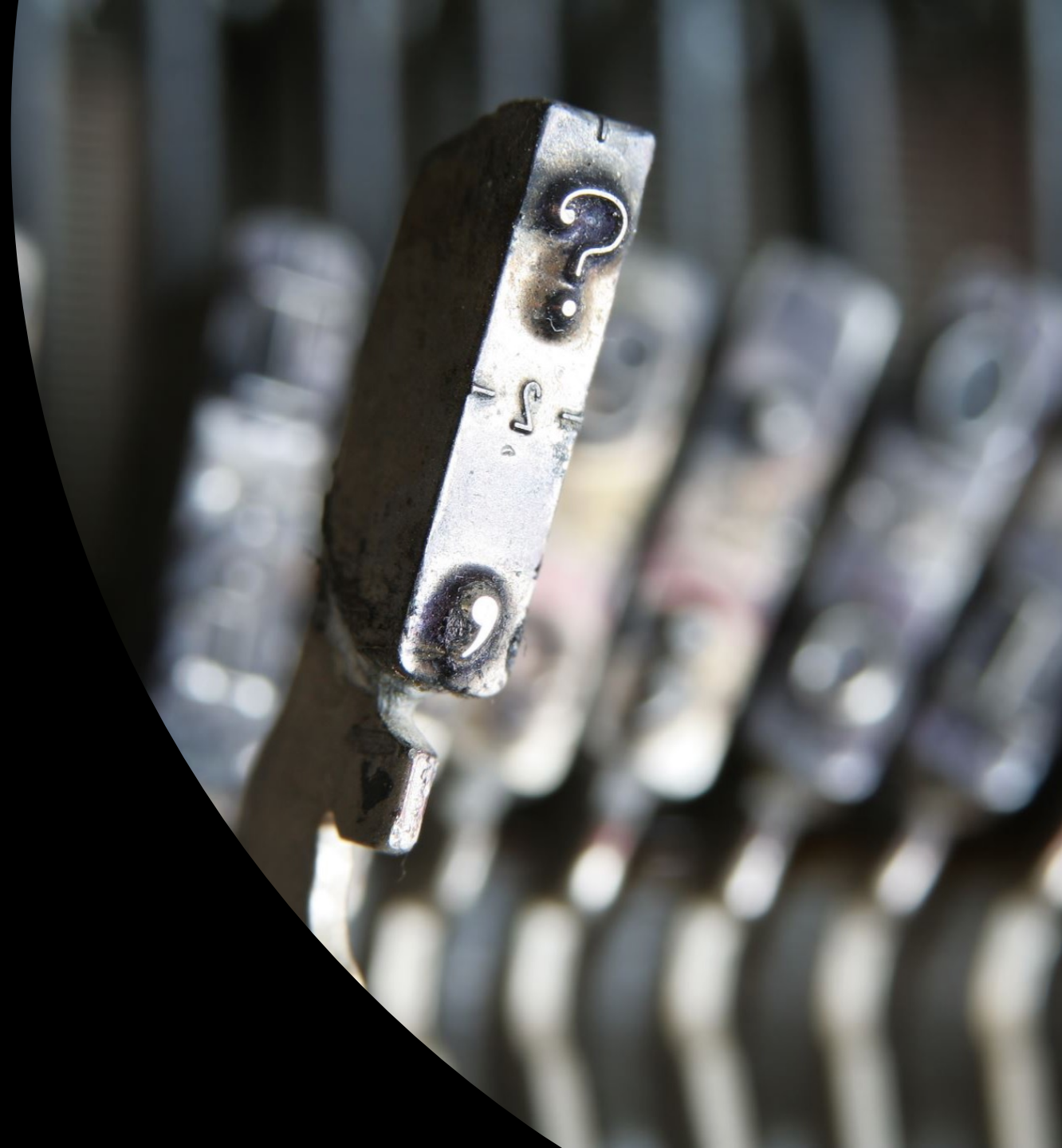
Lymphedema Staging

TABLE 1-1 International Society of Lymphology Lymphedema Staging

Stage*	Clinical Description
0	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.
I	Early accumulation of fluid relatively high in protein content, which subsides with limb elevation. Pitting may occur.
II	Limb elevation alone rarely reduces tissue swelling, and pitting is common.
III	Lymphostatic elephantiasis in which pitting can be absent and trophic skin changes, such as acanthosis, fat deposits, and warty overgrowths, develop.

*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

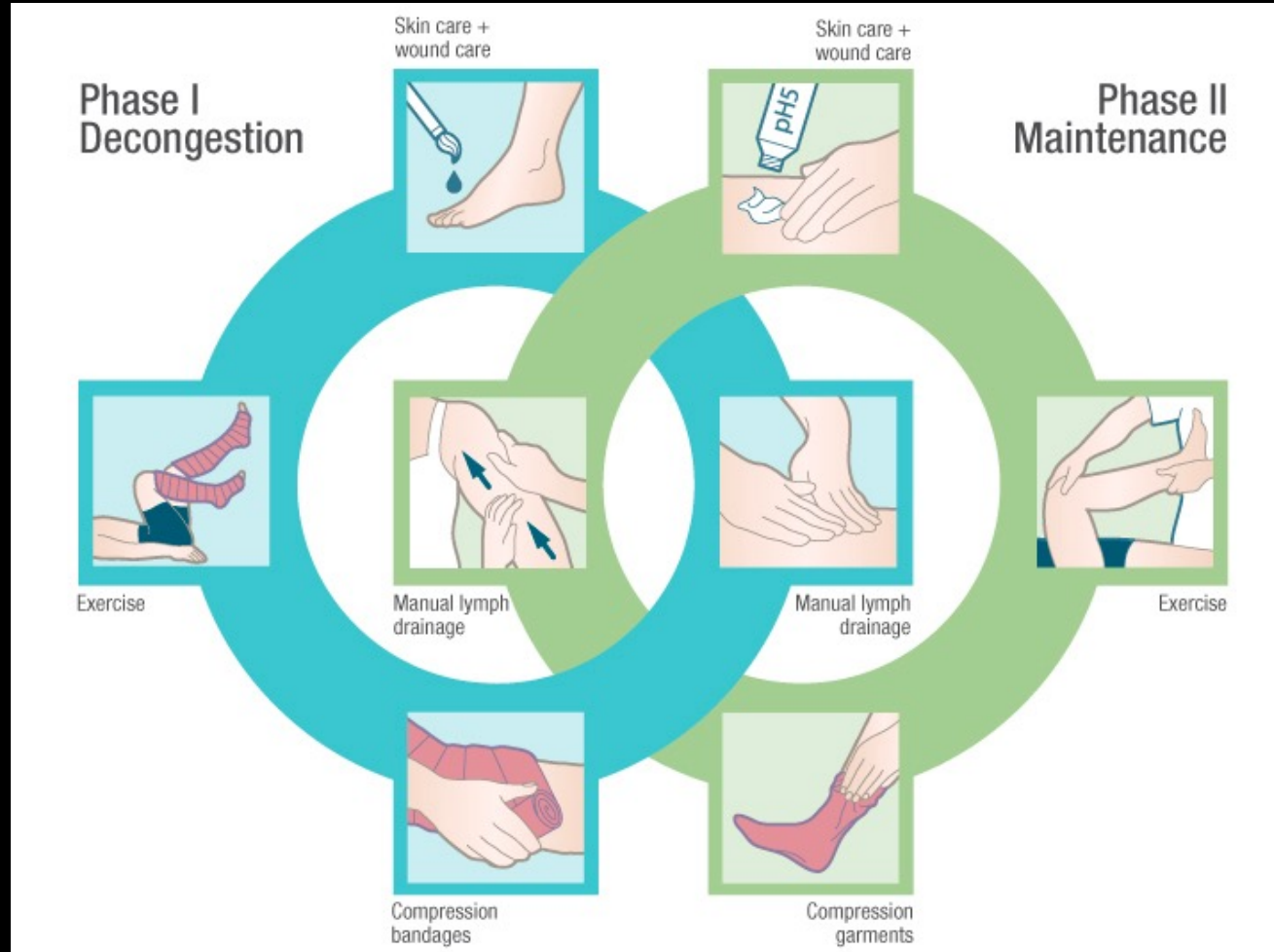
- Prostate Cancer
 - 21% after radical prostatectomy



Cellulitis in Lymphedema

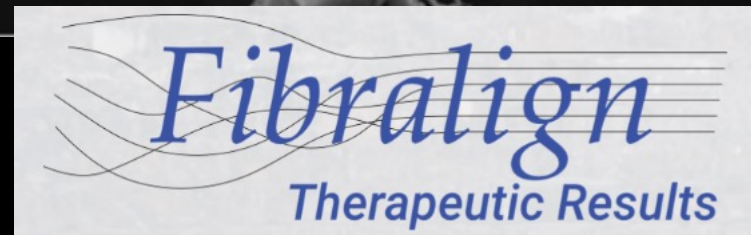
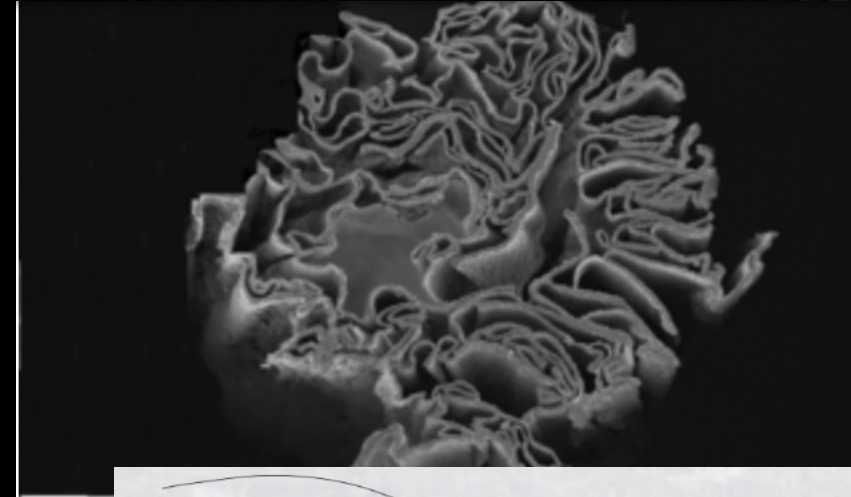
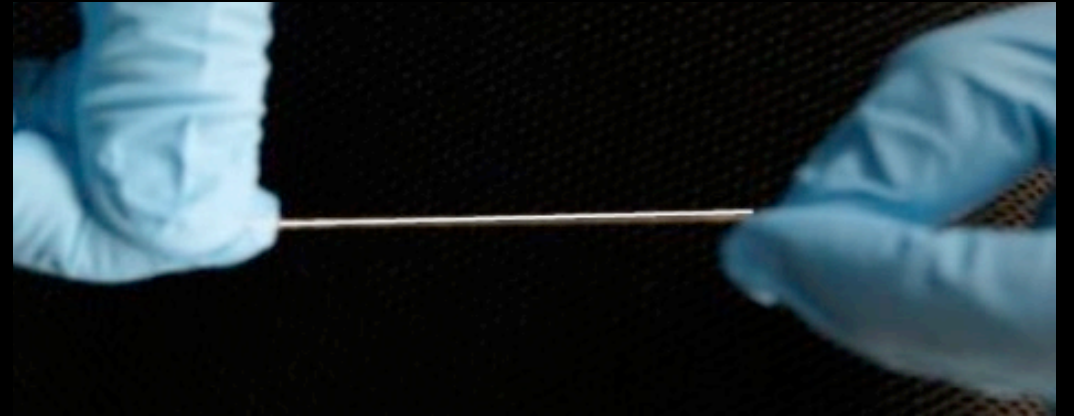
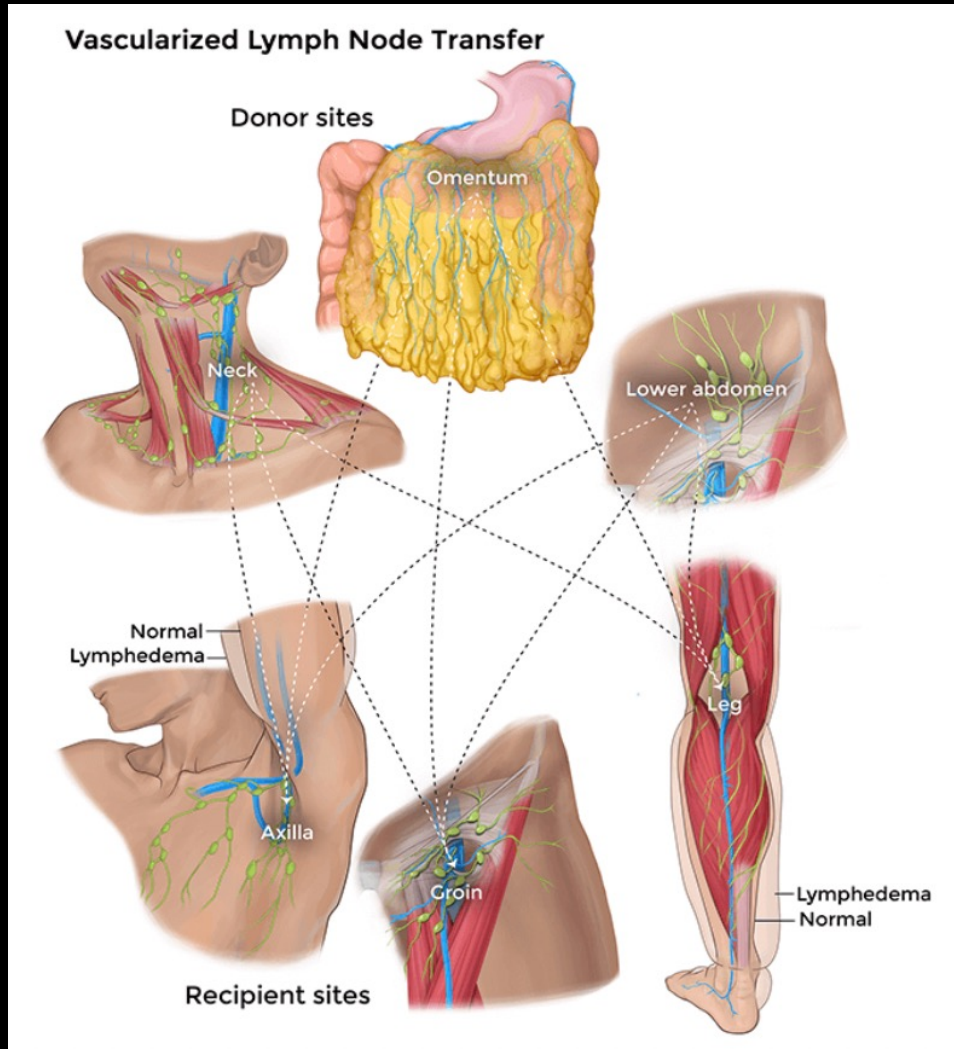


Treatment

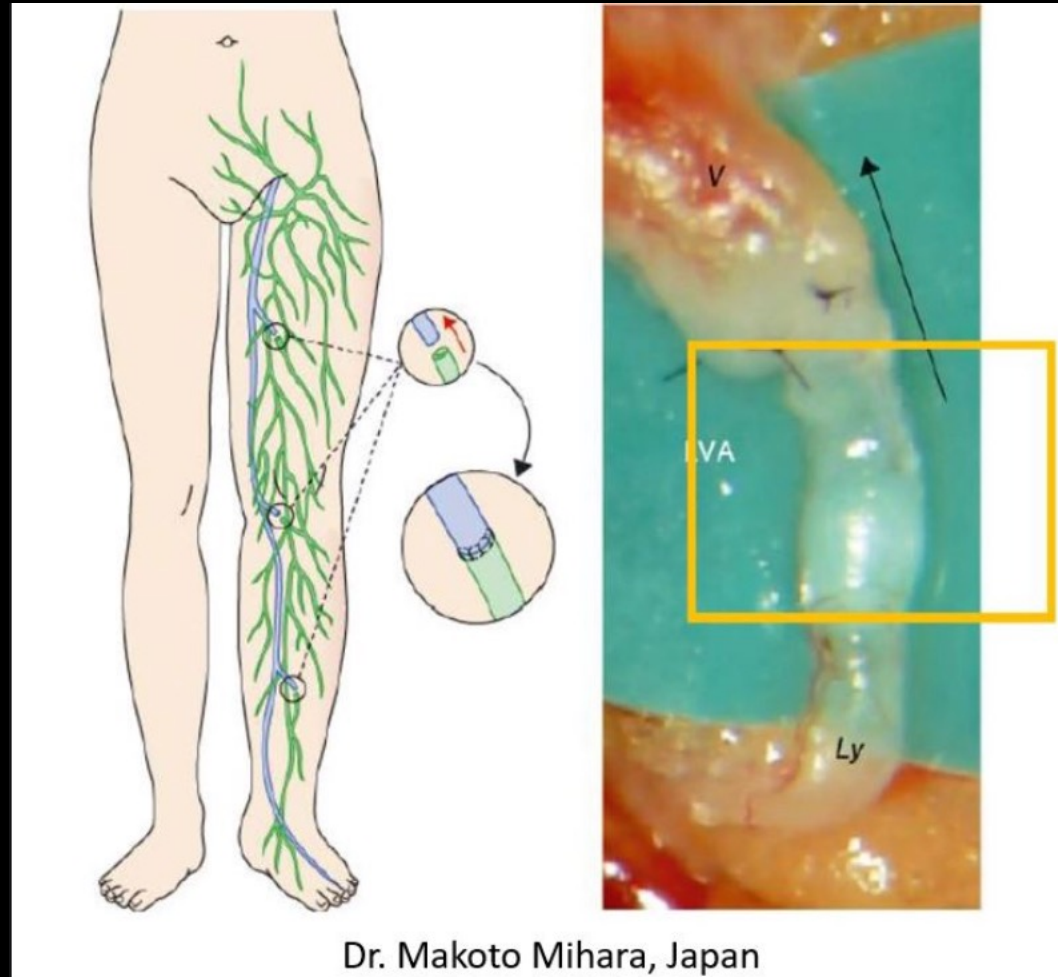


Vascularized Lymph Node Transfer

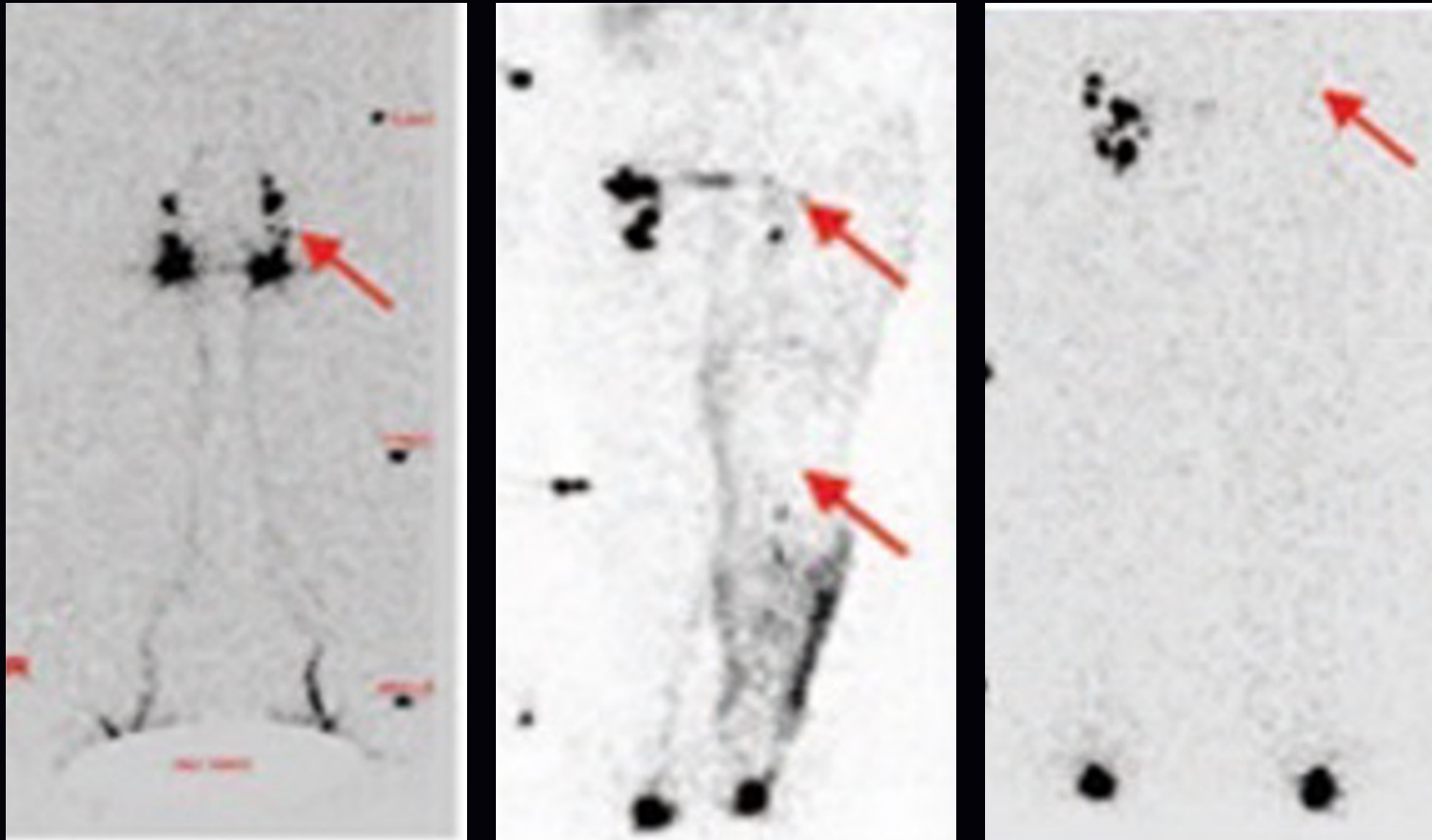
BioBridge



Lymphatic Venous Anastomosis

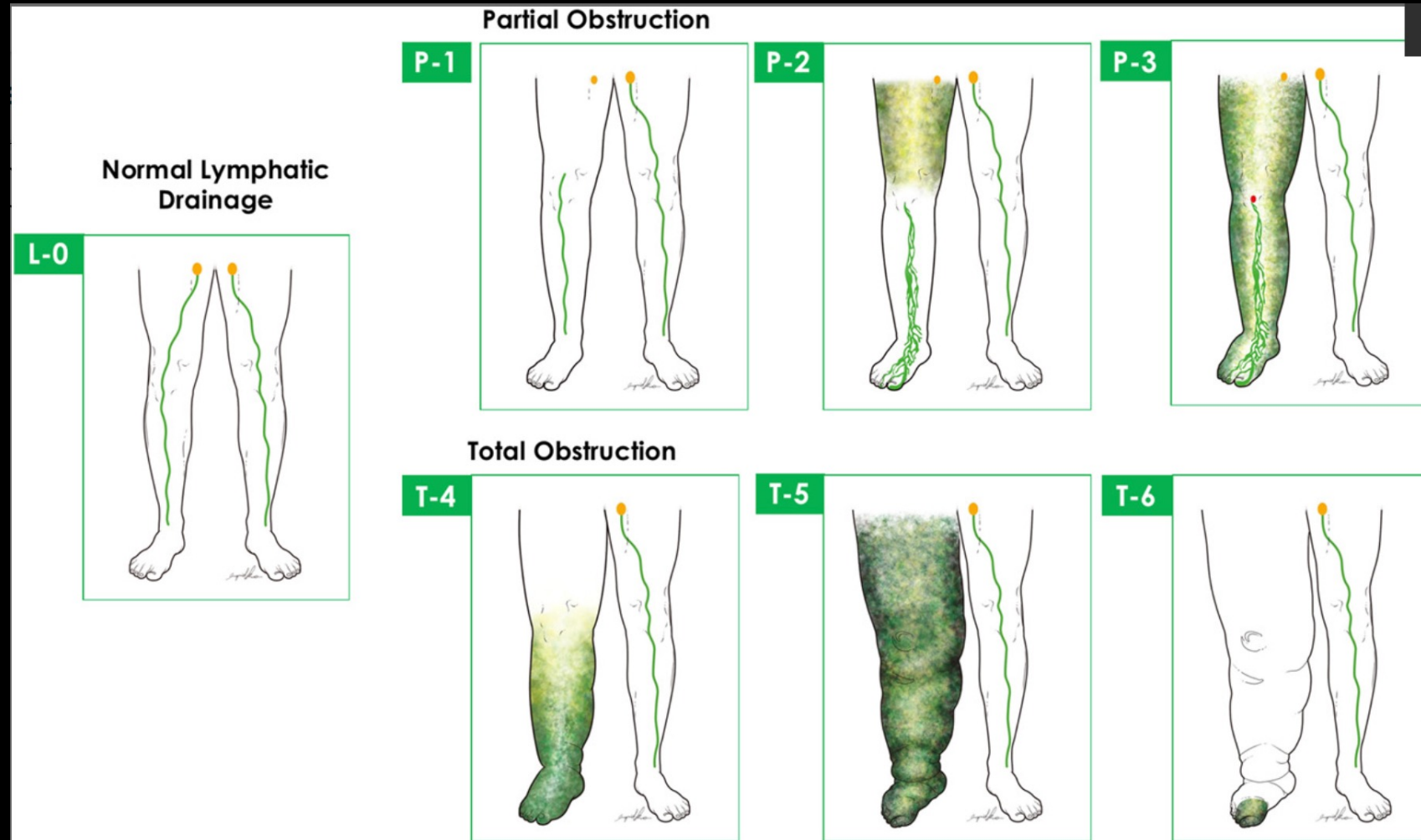


Lymphoscintigraphy

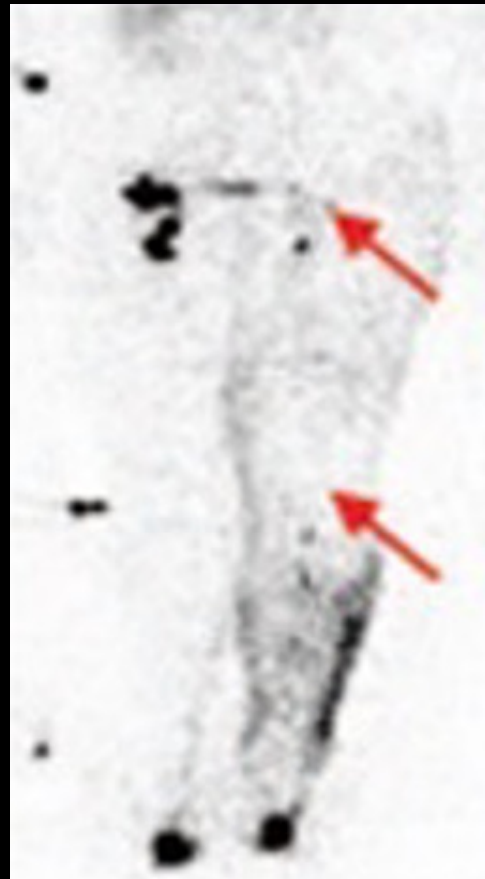


- CiteCheng, Ming-Huei MD, MBA, FACS^{*}; Pappalardo, Marco MD, MSc^{*,†}; Lin, Chieh MD, PhD[‡]; Kuo, Chang-Fu MD, PhD^{§,¶}; Lin, Chia-Yu MSc^{*}; Chung, Kevin C. MD, MS^{||} Validity of the Novel Taiwan Lymphoscintigraphy Staging and Correlation of Cheng Lymphedema Grading for Unilateral Extremity Lymphedema, *Annals of Surgery*: September 2018 - Volume 268 - Issue 3 - p 513-525 doi: 10.1097/SLA.0000000000002917

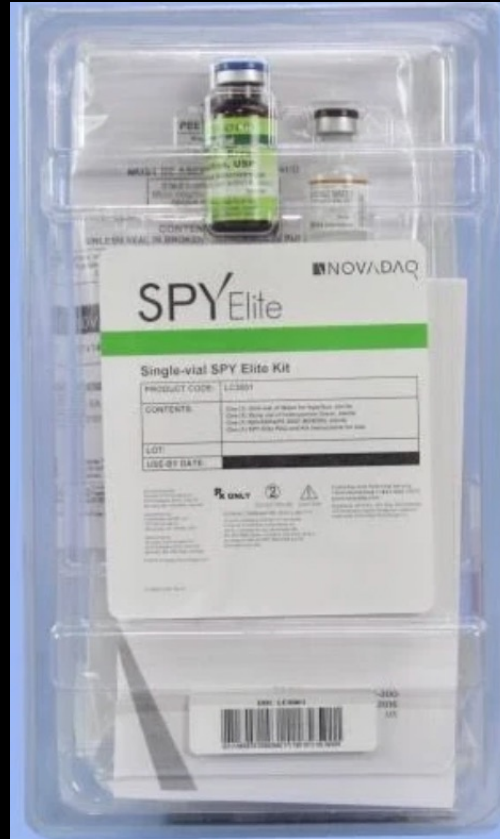
Lymphoscintigraphy



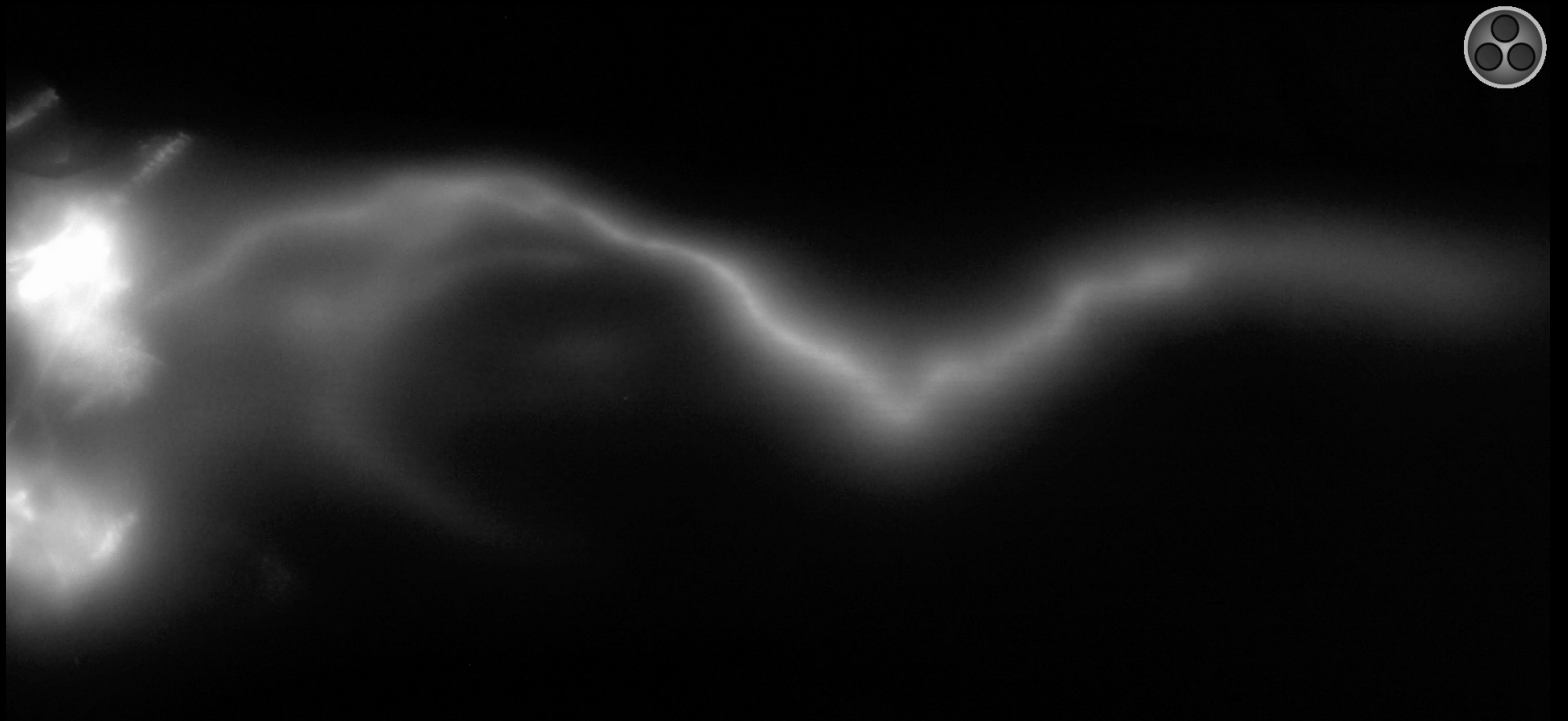
How do surgeons use this?



Indocyanine Green Lymphography



Indocyanine
Green
Lymphography

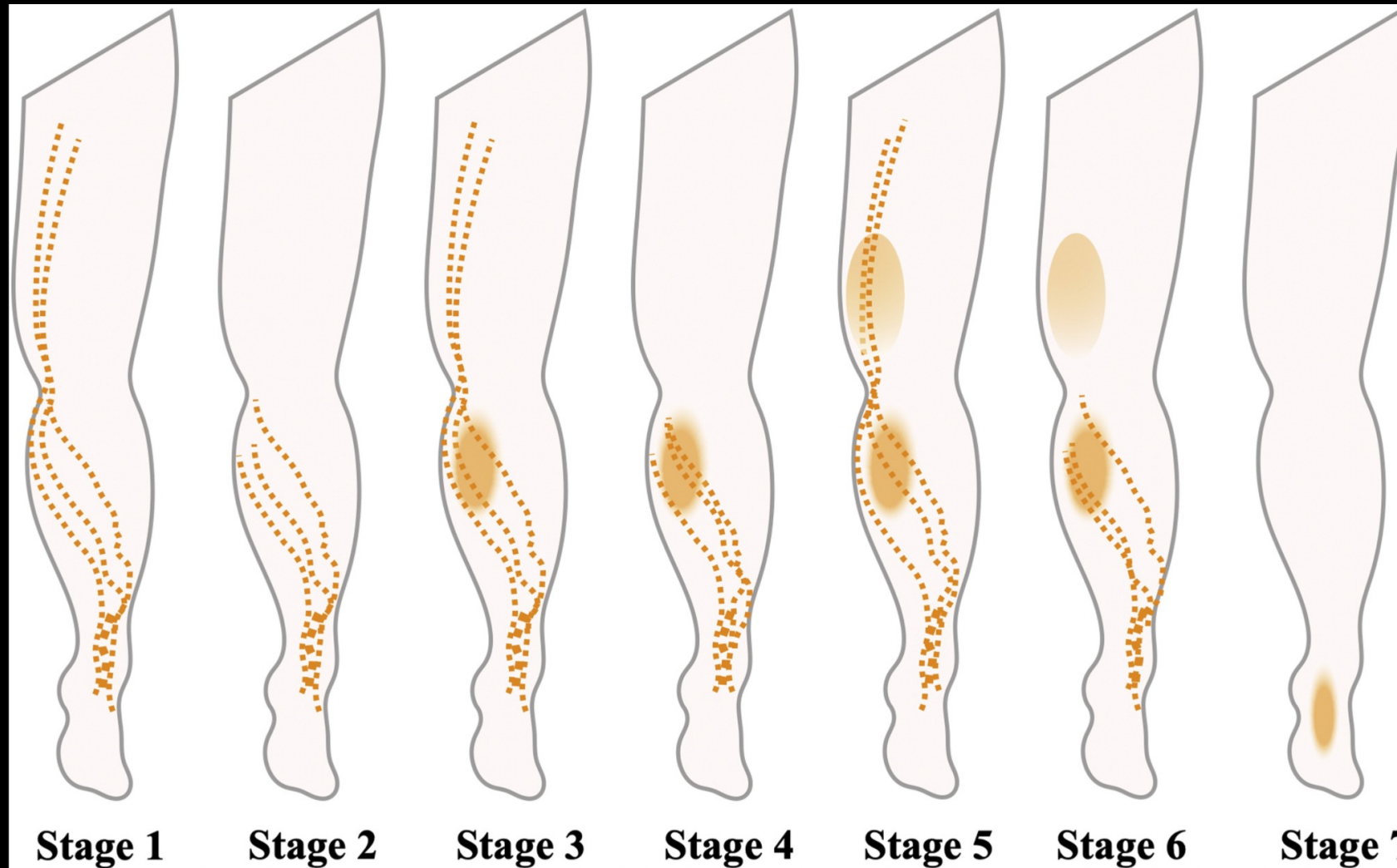


MR Lymphangiography

MR Lymphangiography

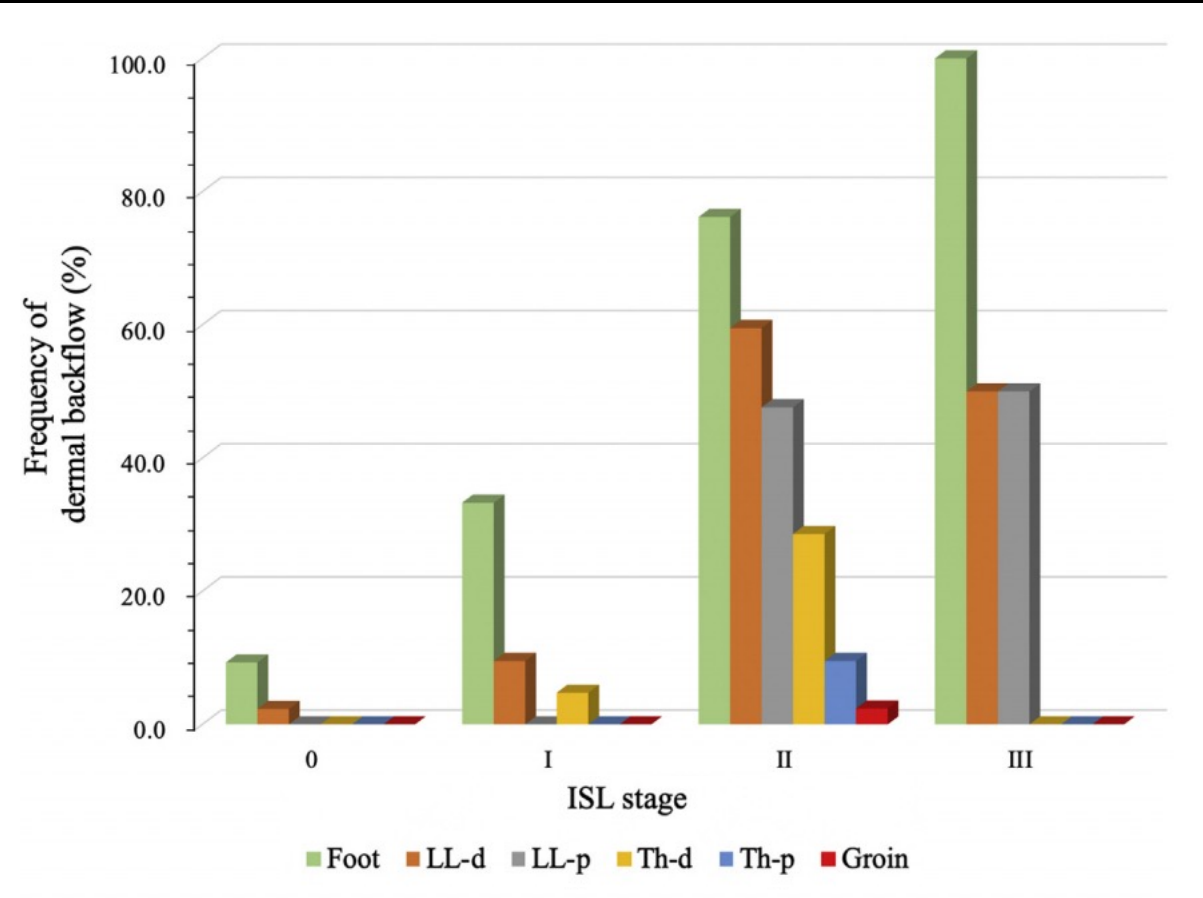


MR Lymphangiography

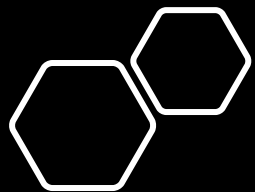


Soga S, Onishi F, Mikoshi A, Okuda S, Jinzaki M, Shinmoto H. Lower limb lymphedema staging based on magnetic resonance lymphangiography. *J Vasc Surg Venous Lymphat Disord*. Published online August 2021:S2213333X21003012.

Dermal Backflow



Soga S, Onishi F, Mikoshi A, Okuda S, Jinzaki M, Shinmoto H. Lower limb lymphedema staging based on magnetic resonance lymphangiography. *J Vasc Surg Venous Lymphat Disord*. Published online August 2021:S2213333X21003012.



Contrast Agents

- Gadolinium containing agents small molecular sizes (~1nm, ~1kD)
 - Diffuse into the veins



Lymphatics or Veins?



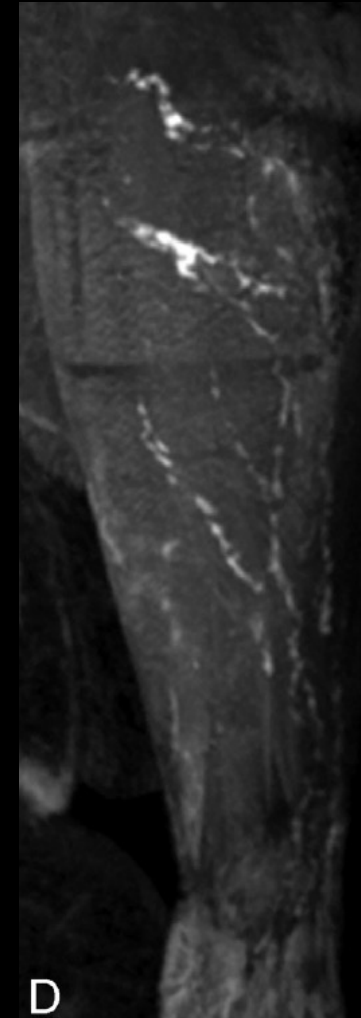
Dual Agent Relaxivity Contrast - MRL



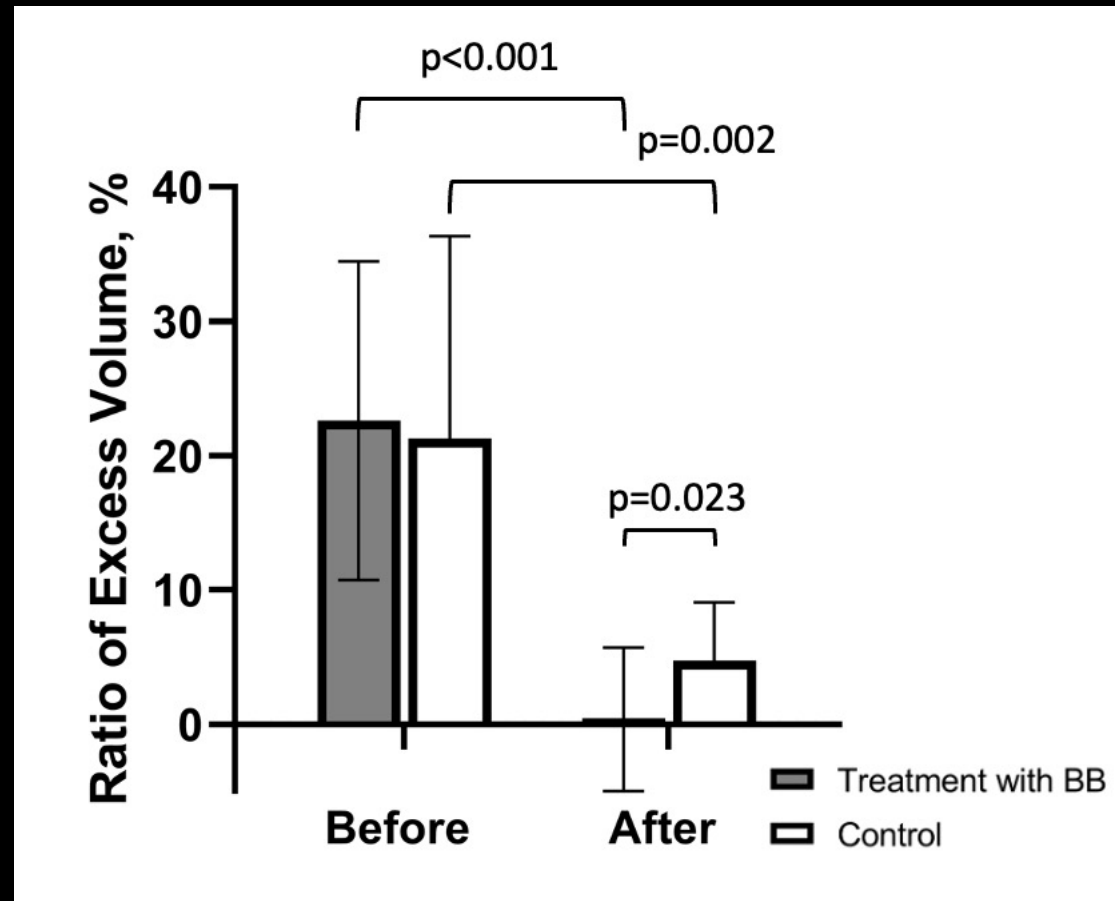
+



=



LVA/VLNT (Control) vs. LVA/VLNT + BioBridge



Nguyen DH, Zhou A, Posternak V, Rochlin DH. Nanofibrillar collagen scaffold enhances edema reduction and formation of new lymphatic channel collectors after lymphedema surgery. *Plast Reconstr Surg.* 2021; Accepted for publication.

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

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



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