COMPREHENSIVE OVERVIEW OF LYMPHEDEMA

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OBJECTIVES

- Appreciate the relationship between the integument and AVL (arterial, venous, lymphatic = VAIL) systems with respect to edema formation
- Understand the pathophysiology of edema
- Recognize that all forms of edema have underlying lymphatic dysfunction (lymphedema continuum)
- Identify the clinical characteristics of phlebolymphedema
REDEFINING THE CIRCULATORY SYSTEM

http://jeltsch.org/static/publications/jeltsch03/index.html
LYMPHATICS: A NODAL-CENTRIC IMMUNO-VASCULAR SYSTEM
LYMPHATICS:
BODY’S DRAINAGE AND WASTE MANAGEMENT SYSTEM
Three layers of lymph capillaries located in the dermis

How many anatomical cross-sections of the skin also include the lymphatic capillaries?

Very few!

3mm!!
Lymphatic Capillaries

Spider web-like network
LYMPHATIC CAPILLARIES: SWINGING TIPS & ANCHORING FILAMENTS

Edema (blue) stretches skin and opens swinging tips.

Langerhan’s cell enters lymph capillary.

Anchoring filaments open lumen.
One of the main functions of the lymphatic system is to facilitate fluid movement from the tissues back to the blood circulation…. *maintain a normal fluid balance*
PURPOSES OF THE LYMPHATIC SYSTEM

1. Fluid in the interstitial spaces is continuously circulating.

http://www.mhhe.com/biosci/ap/histology_mh/lymphct.html

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2. The lymphatic system acts as a safety valve for fluid overload and helps keep edema from forming.
3. The homeostasis of the extracellular environment is maintained by the lymphatic system.
4. The lymphatic system also cleanses the interstitial fluid and provides a blockade to the spread of infection or malignant cells in the lymph nodes.

Langerhan’s cells in Stratum Granulosum and Spinosum

Lymphocyte attacking cancer cell
Lymphatic Anatomy & Physiology

Territories

• Root areas/skin areas which comprise the regional drainage of select or groups of lymph nodes

Watersheds

• Boundaries
• Separate lymphatic territories
• Physiological/anatomical areas where there are little to no lymphatics

Anastomosis

• Lymphatic ‘superhighways’ connecting regional lymph nodes

Understanding this guides individualized treatment to maximize fluid reduction (CDT)
LYMPHATICS: THE UNDERVALUED MISSING LINK

• The lymphatic system is also tasked with the absorption and transportation of lipids and fatty acids to the circulatory system, and transporting antigens, antigen-presenting cells and other immune cells to the lymph nodes where adaptive immunity is stimulated

• Disorders of the lymph system, whether systemic (macro-lymphedema) or localized (micro-lymphedema), produce cutaneous regions susceptible to infection, inflammation and carcinogenesis (skin barrier failure)


• A functional lymphatic system is essential to an organism’s overall health given its role in fluid homeostasis, removal of cellular debris and mediating immunity and inflammation


Lymph/Integ Connection!! Contributes to development or chronicity of chronic wounds. Impairment in one system can lead to dysfunction in others...
STARLING’S LAW REDEFINED

**Previous Understanding**

**Capillary Fluid Exchange**

- **Hydrostatic Pressure:** Favors filtration of plasma out of capillaries
- **Osmotic Pressure:** Favors osmotic movement of interstitial fluid into capillaries

**New Understanding**

- **Endothelial Glycocalyx Layer (EGL):** gel-like matrix with hair-like projections extending into lumen of blood vessels; acts as molecular sieve regulating fluid and macromolecule movement
- Only a diminishing net filtration across capillary bed

Reprinted with permission from Biddle, C., 2013. Like a slippery fish, a little slime is a good thing: the glycocalyx revealed. AANA Journal, 81(6).
The EGL is dynamic and can “shed” in response to stimuli, such as during inflammation or disease states. Shedding is conceptualized as a dog shedding its fur. During inflammation, this shedding allows more fluid to escape through the EGL. (Biddle, 2013; Weinbaum, Tarbell, and Damiano, 2007) EGL sheds in response to inflammation, ischemia, sepsis, trauma, atherosclerosis, diabetes, intravenous fluid mis-management (Biddel, 2013; Reitsma et al., 2007) as well as prolonged immobility and anti-gravity environments (Belgrado lecture Peachtree City, GA Dec 2017).
The dense, capsular design of the lymph nodes, placement in joint areas that are mechanically compressed by movement, and presumed absence of EGL, all work synergistically to facilitate fluid reabsorption back into the venous system.

Conversely, immobility and decreased joint movement through the full range of motion, lymph node removal, or venous hypertension, can have a significant impact on fluid retention in the dermis and subcutaneous tissues.

All fluid, proteins and macromolecules are removed from the interstitium by the lymphatics alone (capillaries and nodes).
STARLING’S LAW REDEFINED

There is no re-absorption in the blood capillaries; fluid is returned to venous system/vascular compartment by the lymphatics

Paradigm Shift

“Arguably, it may be better to consider the presence of chronic edema as synonymous with the presence of lymphedema, inasmuch as all edema represents relative lymph drainage failure.”

—Dr. Stanley Rockson, Stanford Medical Ctr.
THE LYMPHEDEMA CONTINUUM

Lymphatics Temporarily Overwhelmed

Overwhelmed…Most Edemases
Transient lymphedema

Lymphatic Transport Capacity

Lymphatics Permanently Impaired or Damaged

Permanently Damaged…
The Disease of Lymphedema

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**Edema**

abnormal excess accumulation of serous fluid in connective tissue. Lymphatic system is *temporarily overwhelmed*, but not permanently damaged.

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**Lymphedema**

accumulation of protein rich fluid in an extremity or body part as a result of *damage or loss* of part of the lymphatic vessel system.

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Low protein edema

Protein rich edema
ETIOLOGY OF LYMPHEDEMA

Lymphedema can be primary (congenital) or secondary (acquired).

Typically involves the extremities but can include trunk, genitals and other body locations.

Unilateral or bilateral yet always asymmetrical.
CAUSES OF SECONDARY LYMPHEDEMA

- **Malignant tumors** - the presence of cancer tumors can block the flow of lymph fluid
- **Surgery (cancer and non-cancer related)** – increases the risk of disturbing the function of lymphatic pathways
- **Radiotherapy** - destroys cancerous and regional lymphatic tissues – Most common cause US
- **Infections** – contributes to increased swelling and fibrosis in the affected area – Filariasis main cause worldwide
- **Inflammation** – contributes to excess scarring and lymphatic blockage
- **Obesity** – increased the pressure on the lymphatic system that could ultimately damage lymph nodes
- **Disease** - for example, venous insufficiency - phlebolymphedema
- **Trauma** - lymphoedema following severe trauma
# Lymphedema Stages

| Stage 0       | (Subclinical or latent) | - No visible changes  
|              |                         | - Period of time from reduced lymphatic transport to when lymphoedema occurs  
|              |                         | - Altered sensation, for example, mild heaviness  
|              |                         | - People can be in this stage for a long period of time before symptoms fully develop  
| Stage 1      | (Mild)                  | - Slight swelling in affected area  
|              |                         | - High-protein fluid builds up in the interstitium  
|              |                         | - Pitting oedema occurs when skin is pressed  
|              |                         | - Symptoms can be cured by treatment because skin isn’t permanently damaged. For example, elevating the arm  
| Stage 2      | (Moderate)              | - Results from lack of treatment during Stage 1  
|              |                         | - Increased swelling and tissue damage present (tissue is hard)  
|              |                         | - Symptoms can be managed through treatment but not cured  
| Stage 3      | (Severe)                | - Uncommon for people with breast cancer  
|              |                         | - Final stage, affected limb becomes deformed and skin is badly damaged  

PATHOPHYSIOLOGY

Disorders of Lymph Drainage

• Protein rich fluid accumulates in the tissue
• Interstitial “ground substance” swells
• Characteristics of protein rich fluid
  • Macrophages (Blue)
  • Fibroblasts (Green) produce collagen
• Connective tissue proliferation
• Fibrosclerosis
PATHOPHYSIOLOGY
LYMPHEDEMA RESULTS IN CHRONIC INFLAMMATION & STAGNANT WOUND MILIEU

“…stagnating high protein edema develops a patho-histological state of chronic inflammation, with infiltration of the tissue by mononuclear cells, angiogenesis, proliferation of connective tissue, fibrosis and fibrosclerosis…”

“Oxidation & degradation of interstitial proteins attracts monocytes that change into macrophages. Macrophages ingest the proteins and activate fibroblasts that, in turn, form collagen resulting in connective tissue proliferation.”

Also triggers adipocytes, leading to fatty tissue proliferation (spongy lymphedema).

“…all edema indicates an inadequacy or failure of lymphatic drainage…”


“…Lymphatic failure is responsible for all forms of peripheral edema…”

- Diagnosis and treatment of primary lymphedema consensus document of the International Union of Phlebology (IUP) 2013
HOW DOES THIS RELATE TO VENOUS DISEASE?
Etiology: Insufficiency of venous system due to valvular failure of deep, perforating, or superficial veins.

Results in regurgitation of blood in the veins.

Impairs capillary function due to increased pressure (AVL).

Creates dermal backflow of lymphatic fluid.

Dual Outflow System Failure
Chronic venous insufficiency

Lymphedema is underlying pathology contributing to formation of venous ulcers

High filtration pressure/increased fluid in tissues

Lymphatic damage

Waterload exceeds lymphatic transport capacity

Lymphatic hypertension leads to fibrosclerosis

Low protein edema
PHLEBOLYMPHEDEMA DEFINED

≥ C3 = CVI = 2° LYMPHEDEMA!

• Appropriate skin and wound management
• Endovenous ablation
• Endovascular therapy
• Medications
• Weight management
• Lifestyle modification
• Walking/exercise regimen
• Compression
Complete Decongestive Therapy

Intensive phase provided by trained healthcare professional

Provided until limb is decongested and stable

Maintenance phase by patient or caregiver

Modified CDT for life
CLINICAL PEARLS

- Edema is the clinical manifestation of either an overwhelmed or damaged lymphatic system; one is transient the other is a disease and both are part of the lymphedema continuum.

- The venous, arterial, integumentary, and lymphatic systems (think VAIL) are inter-related; dysfunction in one system will lead to dysfunction in the other systems (may be subclinical or overt).

- Lymphatic impairment leads to local areas of compromised skin barrier function rendering the skin more prone to breakdown and impairments.

- Movement enhances VAIL promoting more optimal functioning (muscle pump, nodes near joints, vascular integrity/health).

- Compression is essential with venous and lymphatic disease even before clinical evidence of edema.
The venous and lymphatic systems are mutually interdependent
- When dysfunctional the result is a dual outflow system failure
- Severe phlebolymphedema is caused by combined high lymphatic flow and low lymphatic drainage
- Phlebolymphedema (not cancer) is the most common cause of lower extremity secondary lymphedema in Western countries
- The pathophysiology of lymphedema explains the propensity for infections (cellulitis) and hypersensitivity reactions in patients with CVI
- Complete Decongestive Therapy is indicated for the management of Phlebolymphedema along with appropriate skin and wound management
A pathological deposition of fatty tissue, usually below the waist, leading to progressive leg enlargement

- Occurs almost exclusively in women
- May be inherited
- Frequently misdiagnosed as lymphedema
- Often confused with obesity
- Diagnosis is clinical
Lipedema Key Symptoms

- Feeling of heaviness in the legs (aching dysesthesia)
- Easy bruising due to a lack of anchoring of the small capillaries in the connective tissue, which results in tearing when affected by the pull of gravity
- Sensitivity to touch (painful fat syndrome)
- Orthostatic edema during long periods of standing
- May have “oatmeal changes” to the skin
- Fat pad sign (filling of retro-malleolar sulcus)
- Typically, excess adipose accumulation from the ankles to the hips (feet are spared)
Lipedema Additional Considerations

• Knee hyper-mobility
• Knee problems common which may lead to gait impairment
• Fat pads above, inside and below knees and in outer region of upper thighs
• Fat lobes or pads may put stress on joints causing abnormal gait and/or increased joint pain
• Accumulation of lipedemic fat in the upper arms, sometimes leaving large amounts of arm fat hanging when arm is outstretched
  • Research reports a range of 30-90% of people with lipedema are affected in their arms as well
Progressive condition
4 stages and 5 types

www.fatdisorders.org
www.lipedema.net
• Lymphedema schools/certification
  - ILWTI.com
  - Klosetraining.com
  - Acols.com
• Lymphedemablog.com
• Lymphedematreatmentact.org
• Lymphedemanetwork.org
• Lymphcareusa.com
• CLT-LANA.org
• Lipedema.org
• Fatdisorders.org
THANK YOU!

QUESTIONS?