IPC Use in Lymphedema: Physiological Considerations

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Brief Excursion into Normal Physiological Process Consideration
Capillary → Tissue → Lymph Capillary

Lymphatic Capillary Lumen

Lymphatic EC

Interstitium

PT

PL

Leak 1971
Capillary → Tissue → Lymph Capillary

"Blind" Lymphatic Capillary

Lumen

EC

PL

PL > PT

Anchoring Filaments

Blood Capillary

Lumen

EC

PL

PT

PL < PT

Fluid and Protein enter Lymphatic Capillaries

Lymphatic Capillary Lumen

Leak 1971
Lymph taken up by lymphatic capillaries enters lymph collectors.

Lymph Capillary

Walls have a muscular media

Lymphangion (lymph micro heart)

Valve

Collection ➔ Propulsion

Grimaldi et al. 2006
Peristaltic-like contractions propel lymph to next segment

Lymphangion (lymph micro heart)

Walls have a muscular media

Collection → Propulsion

Valve

Contraction force & frequency is preload & afterload dependent - analogous to heart

Grimaldi et al. 2006
Excess
Lymphatics

Fluid + Protein

Excess --> Lymphatics

Normal Lymphatic Function
Overload = Edema

If Net Filtration Exceeds Lymphatic Transport Capacity

Excess --> Lymphatics

Normal Lymphatic Function

Fluid + Protein

= Lymphedema
Lymphatic Drainage Pathways

Lymph flow and drainage determined by normal physiological processes and lymphatic pathways.

Lymph flow through normal pathways reduced or absent due to node or lymph vessel obstruction or dysfunction.
**Therapeutic Strategy**

*Use Alternate Pathways – Stimulate Lymphatics and Optimize Conditions for IPC related pumping*

Lymph flow depends on pathways pressure gradient and resistance
Adjunctive IPC Lymphedema Therapy

ROLE

Phase I ➔ Component of in-clinic therapy
Phase II ➔ At-home maintenance therapy

TYPES

Basic: Few Adjustments – Not Programmable
Advanced: Calibrated-Sequential-Programmable
  • With Truncal Clearance Capability
  • No Truncal Clearance Capability
Physiological Considerations

IPC Compression
• Pattern
• Progression
• Pressure

Not independent considerations
Compression Pattern Examples

Flexitouch® System

“Work & Release”

Drainage
Peristaltic-like Progression

Lympha Press® System

“Squeeze & Hold”

Mayrovitz HN
Physical Therapy
2007;87:1379-1388
Physiological Considerations

✓ Proximal/Central clearance *prior to* forward propulsion
✓ Distal → Central progressive propulsion
A. First sequentially treat lymph receiving regions (1→5) to optimize gradient and minimize resistance for subsequent limb drainage procedures

Mayrovitz et al. Home Health Care Management & Practice 2009;21(5) 325-337
Hammond & Mayrovitz Home Health Care Management & Practice 2010;22(6) 397-402
B. Then progressive treatment of limb and trunk with suitable pump pressure starting at the most peripheral region (5 → 1)
Physiological Considerations

✓ Proximal/Central clearance prior to forward propulsion
✓ Distal → Central progressive propulsion with minimal inhibition of:
  • Distal lymphatic capillary interstitial fluid uptake
  • Lympho-venous flow
Pattern Considerations
Arteriole
Blood Capillary
Lympho Venous Shunt
Venule
reabsorption
Lymphatic Capillary Uptake
Filtration

\[ P = \alpha P_0 \]
\[ P_{\text{pump max}} \approx 40 \text{ mmHg} \]
\[ \alpha \approx 0.6-0.8 \]

Arm: Modi et al. 2007
Leg: Unno et al. 2011

* Olszewski & Engesrgt 1980

\[ P = \alpha P_0 \]
Pressure Considerations
Lower Pressure vs. Higher Pressure

Lower Pressures

• Facilitate lymph movement in functioning lymphatics
• Minimize inhibition of lymph filling during compression
• Minimize potential injury due to higher pressures
• Provide a comfortable treatment experience for patients

Higher Pressures

• Facilitate directional interstitial fluid movement especially if low interstitial hydraulic conductance
Summary View

IPC use in lymphedema should be consistent with Physiological considerations of

- *Initial Central Clearance*
- *Subsequent Progressive Propulsion*
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- *Initial Central Clearance*
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Using compression pressures and patterns that during compression minimally inhibit

- *lymph capillary uptake*
- *lymphatic intrinsic active pumping*
- *lymph – venous uptake and drainage*
Summary View

IPC use in lymphedema should be consistent with physiological considerations of

- Initial Central Clearance
- Subsequent Progressive Propulsion

Using compression pressures and patterns that during compression minimally inhibit

- lymph capillary uptake
- lymphatic intrinsic active pumping
- lymph – venous uptake and drainage

And facilitate lymph vessel and tissue lymph flow via

- Impulse – like progressive compression
- arterial-lymphatic interactions that tend to occur at lower compression pressures
Examples of Some Research Study Outcomes
## Research Study Outcomes

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<td><em>European J of Vasc Endovasc Surg</em></td>
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## Research Study Outcomes

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<td>Legs: Significant ↓Limb volume; significantly improved patient-reported outcomes</td>
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Thanks for your Attention