

Innovations and New Solutions for Measuring Lymphedema: From Laboratory to Clinical Implementation

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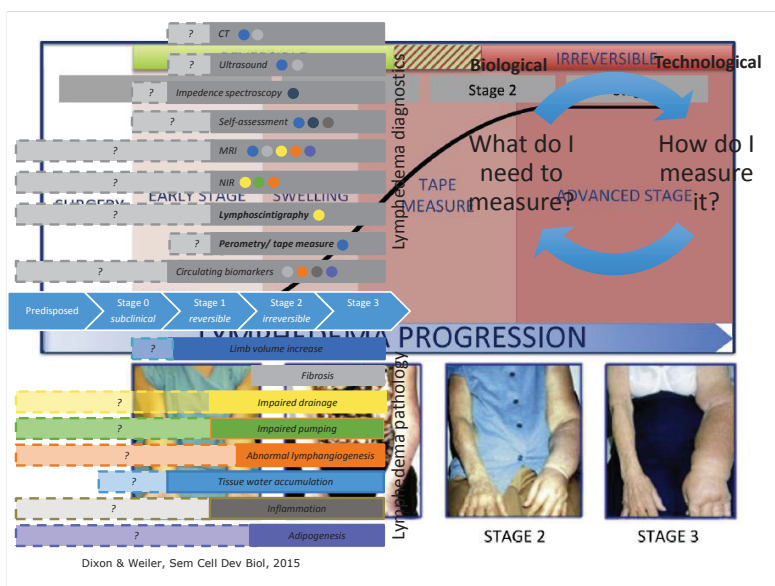


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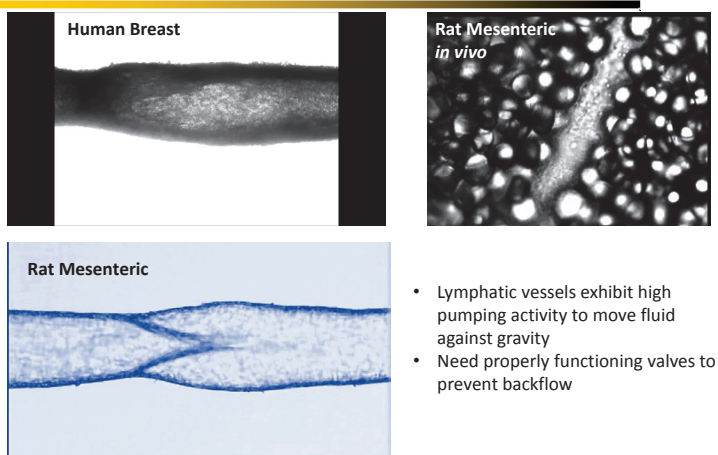
DISCLOSURE

Georgia Tech has licensed technology to LymphaTech that is related to this study and that is covered by patent applications for which Dr. Weiler and Dr. Dixon are inventors. Dr. Weiler and Dr. Dixon own equity in LymphaTech, and Dr. Weiler serves as President and CEO and Dr. Dixon serves as Chief Scientific Adviser. In addition, Dr. Weiler and Dr. Dixon are eligible to receive royalties under the license agreement for LymphaTech.

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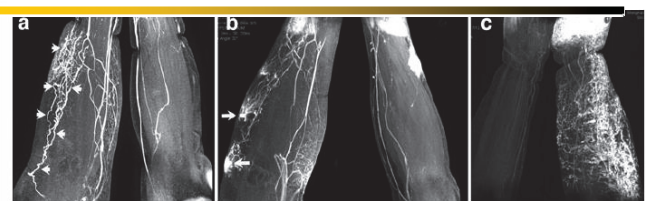
Lymphangions Drive Lymph Flow



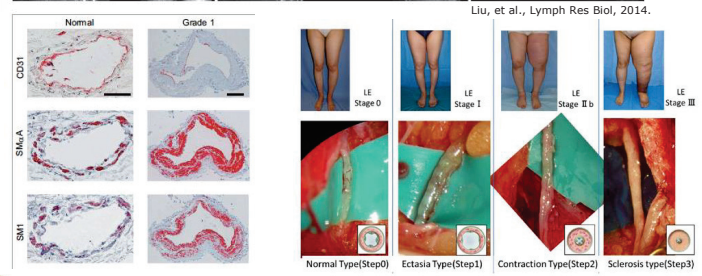
- Lymphatic vessels exhibit high pumping activity to move fluid against gravity
- Need properly functioning valves to prevent backflow



Lymphatics Remodel During Lymphedema



Liu, et al., Lymph Res Biol, 2014.

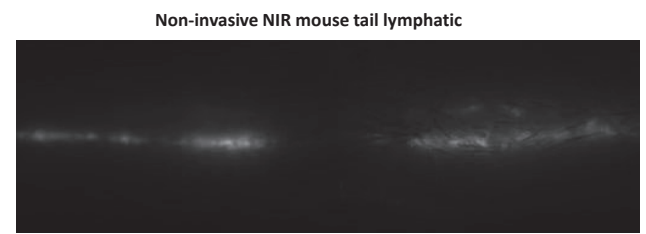
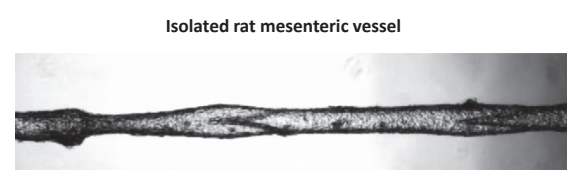


Ogata et al., Br J Dermatol, 2014.

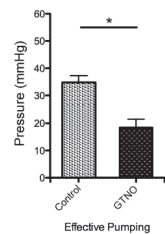
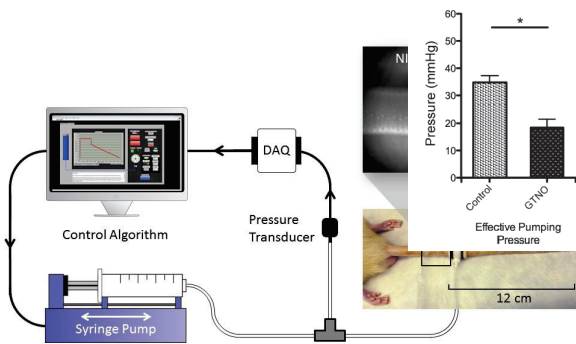
Mihara et al., PLoS One, 2012.



Imaging Lymphatic Function

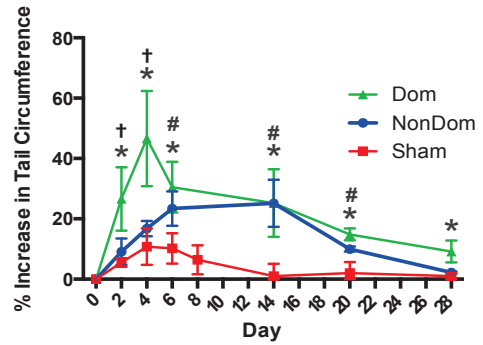


Lymphatic Pumping Pressure

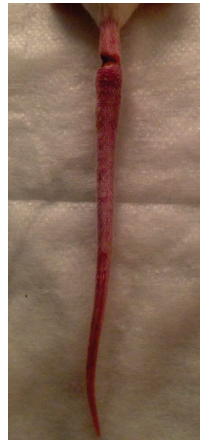


Nelson et al., AJP - Reg Int Comp Phys, 2014

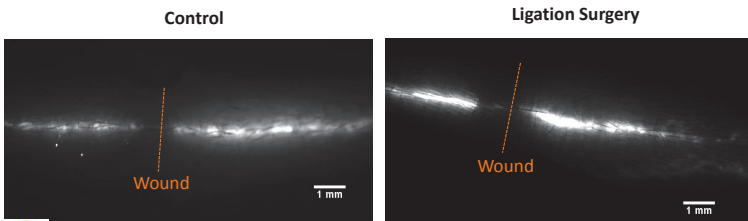
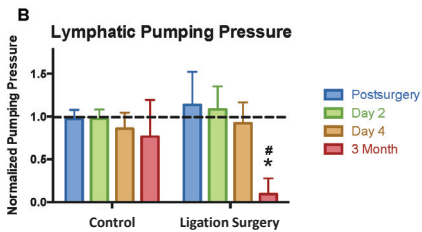
Lymphatic Vessel Ligation Surgery



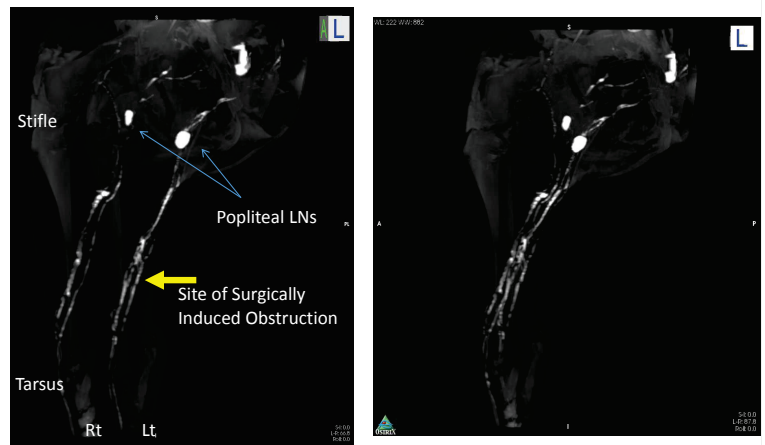
* = significant between Dom and Sham
 † = significant between Dom and NonDom
 # = significant between NonDom and Sham



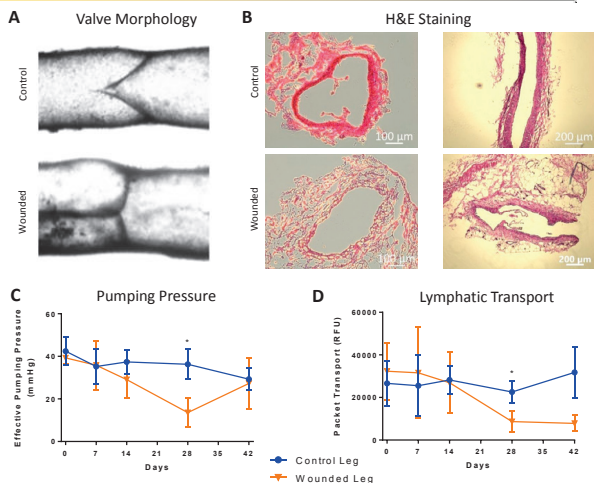
Pumping Pressure Loss in Surgery Model



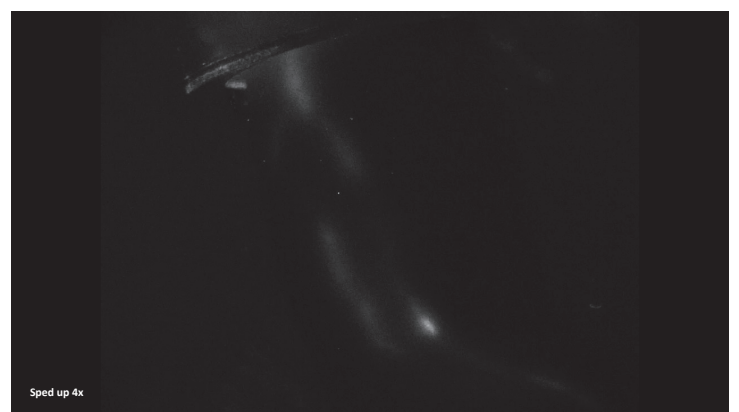
Sheep Model of Lymphatic Adaptation



Reduced Lymphatic Function Post-Surgery



Measuring Pumping Pressure in Humans



Transition Out of the Lab



Georgia Tech **ti:ger**
 Technological Innovation:
 Generating Economic Results



LymphaTech

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Hand-held Mobile 3D Scanning



Depth sensor + iPhone/iPad
 acquires complete 3D rendering in
 less than 1 minute

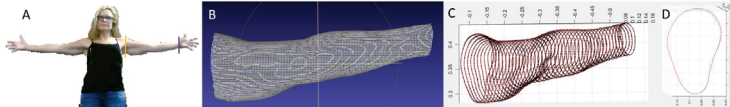
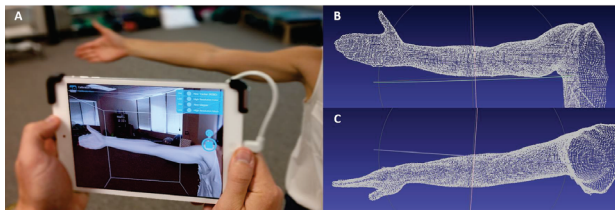
Real time
 visualization &
 metrics required for
 clinical decision

Patient profile
 tracks and trends
 impact of
 treatment



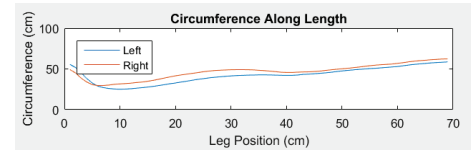
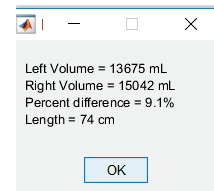
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High-Accuracy 3D Body Measurements

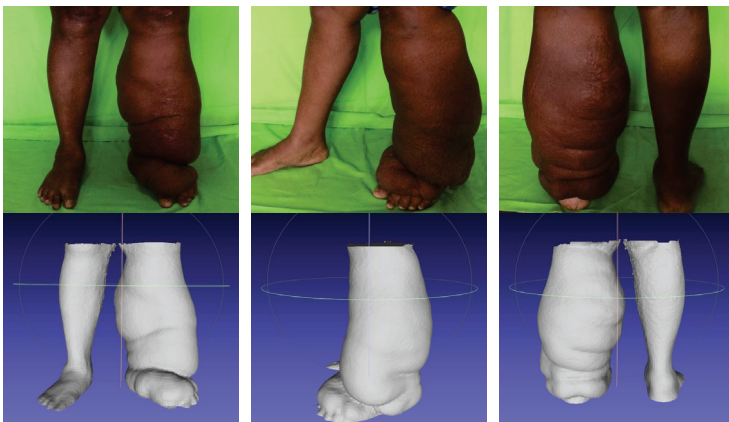


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Solution Enhanced Geometry Measurements and Tracking



High-Resolution 3D Scans



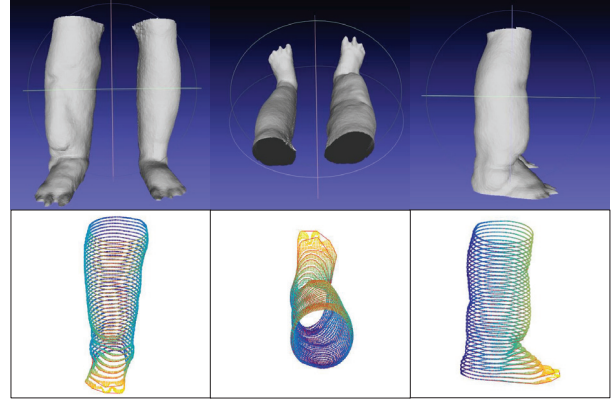
Leg Scan Example



Arm Scan Example



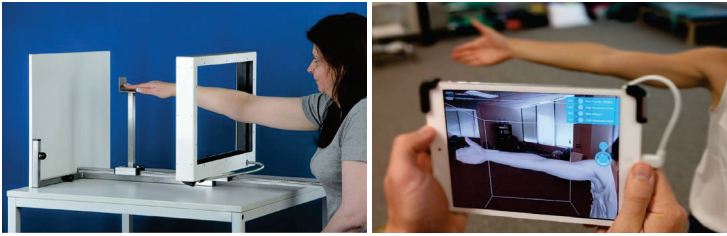
Solution Enhanced Geometry Measurements



Study #1: Validation of Arm Measurements in BC Patients

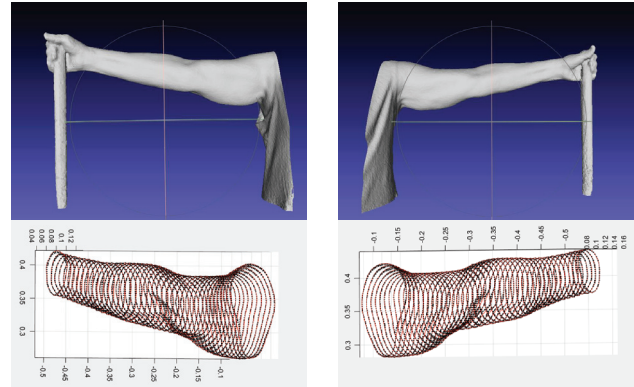


- 250+ total patients scanned over 2 year development period
- 50+ patients scanned with LymphaTech system and Perometer for comparison
- 2 repeats of each scan to measure intra-operator variability of each technique

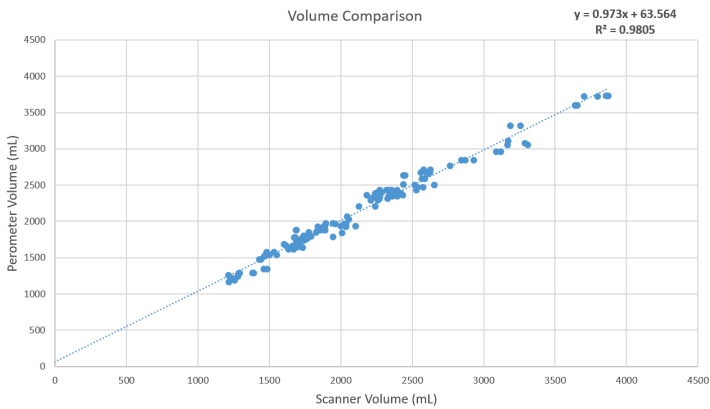


TurningPoint
Breast Cancer
Rehabilitation

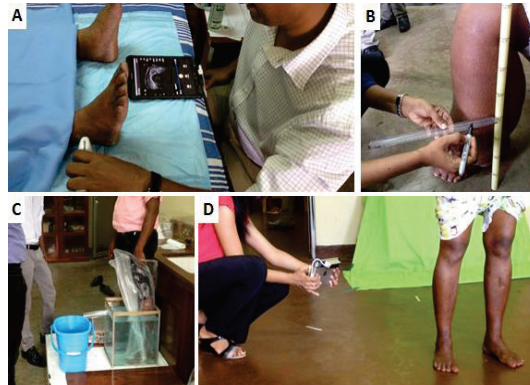
Arm Scanning Automatic Segmentation from Wrist to Axilla



Validation Results Volume – Perometer



Study #2: Validation of Leg Measurements in Filariasis Lymphedema Monitoring



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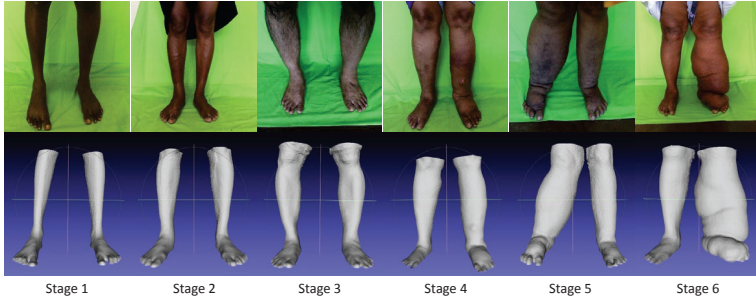
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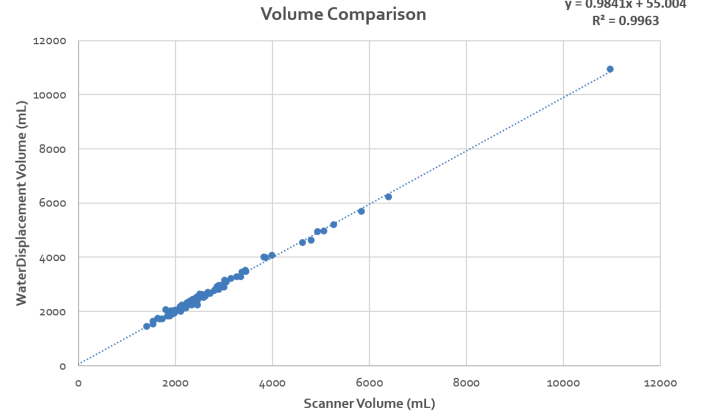
Filaria Validation Study Protocol



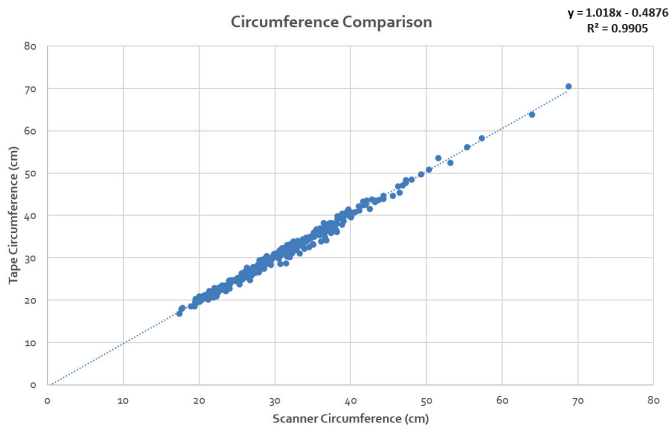
- 65 Patients were scanned and compared to tape measure and water displacement
- 6 local MD operators performed all scans and measurements
- 2 repeats of each measurement performed on each measurement technique



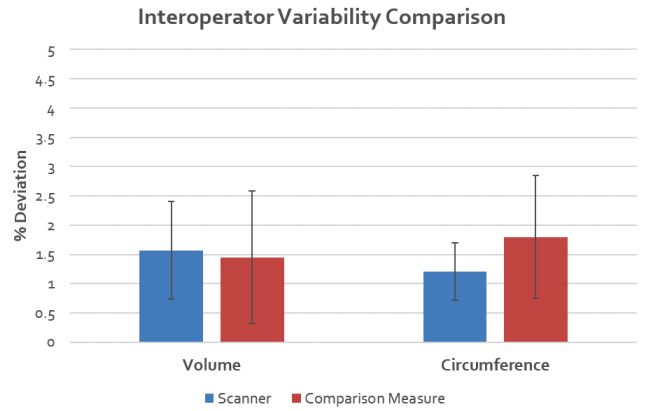
Validation Results Volume – Water Displacement



Validation Results Circumference – Tape Measure



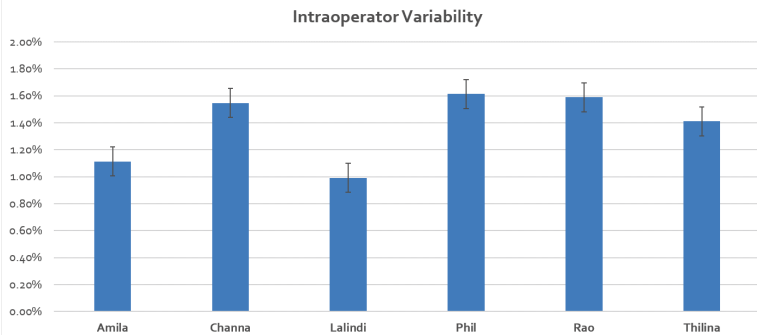
Validation Results Inter-operator Variability



Validation Results Intra-operator Variability



Cumulative Intra-operator Variability = 1.38%



Current Status of Project



ASTMH
AMERICAN SOCIETY OF TROPICAL MEDICINE & HYGIENE
OFFICIAL JOURNAL OF THE AMERICAN SOCIETY OF TROPICAL MEDICINE AND HYGIENE

THE AMERICAN JOURNAL OF
TROPICAL MEDICINE AND HYGIENE
Official Journal of the American Society of
Tropical Medicine and Hygiene

Yahathugoda C, Weiler MJ, Rao R, De Silva L, Dixon JB, Weerasooriya MV, Weil GJ, Budge PJ. Use of a Novel Portable Three-Dimensional Scanner to Measure Limb Volume and Circumference in Patients with Filarial Lymphedema. Published online October 16, 2017. DOI: 10.4269/ajtmh.17-0504.

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Study #3: Validation of Longitudinal Measurements in Lymphedema Patients



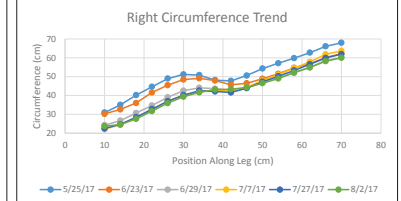
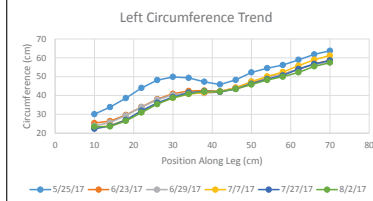
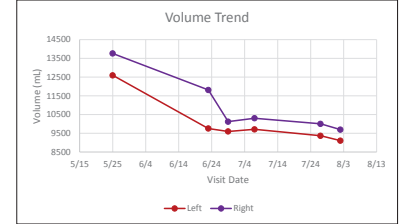
- 150+ patients scanned over 18 month period
- Comparison of response to MLD treatment as calculated with tape measure technique
- 100% trending of measurements from scans compared to tape measure over time



www.lymphedemablog.com



Validation Results Longitudinal Volume and Circumference Tracking



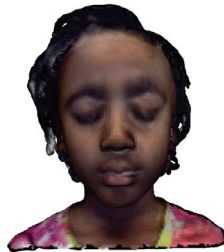
Future Work



Head and Neck



Feet and Hands



Color Scanning

Acknowledgements



Collaborators:

Jill Binkley, PT, CLT-LANA Turning Point Breast Cancer Rehabilitation

John Jordi, PTA, CLT-LANA Benchmark Physical Therapy

Margaret Secrest, PT, CLT-LANA Benchmark Physical Therapy

Phillip Budge, MD, PhD Washington University in St. Louis



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