

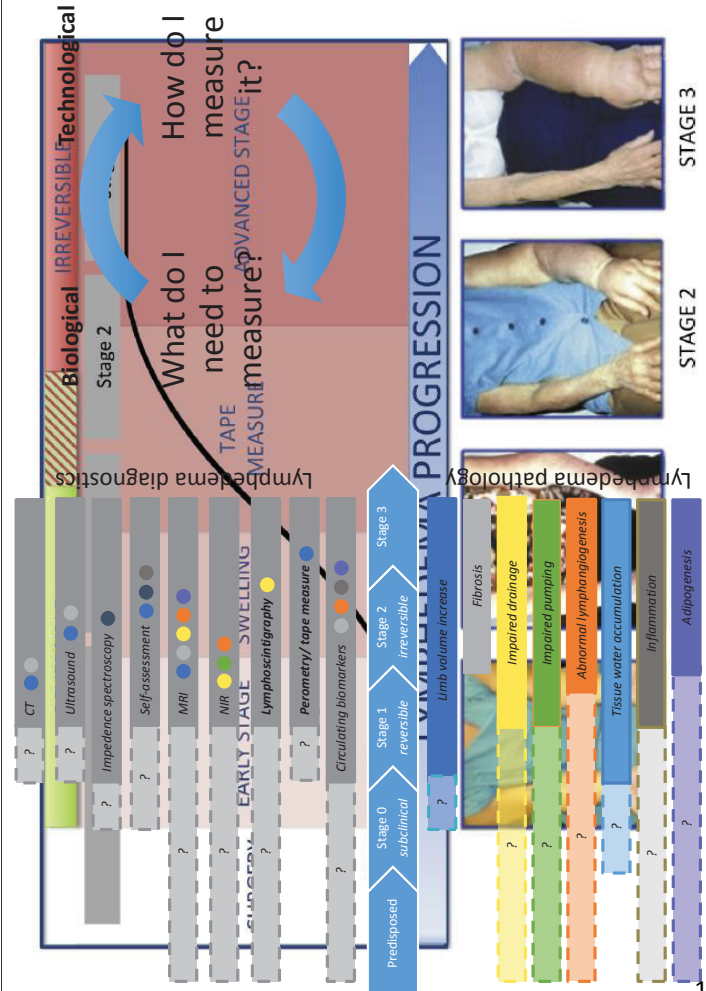
Innovations and New Solutions for Measuring Lymphedema: From Laboratory to Clinical Implementation

Michael J. Weiler, PhD & J. Brandon Dixon, PhD

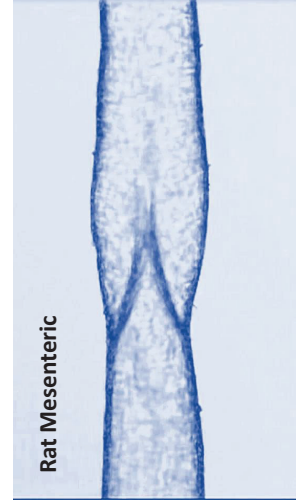
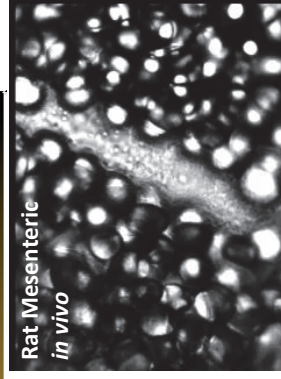


DISCLOSURE

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.



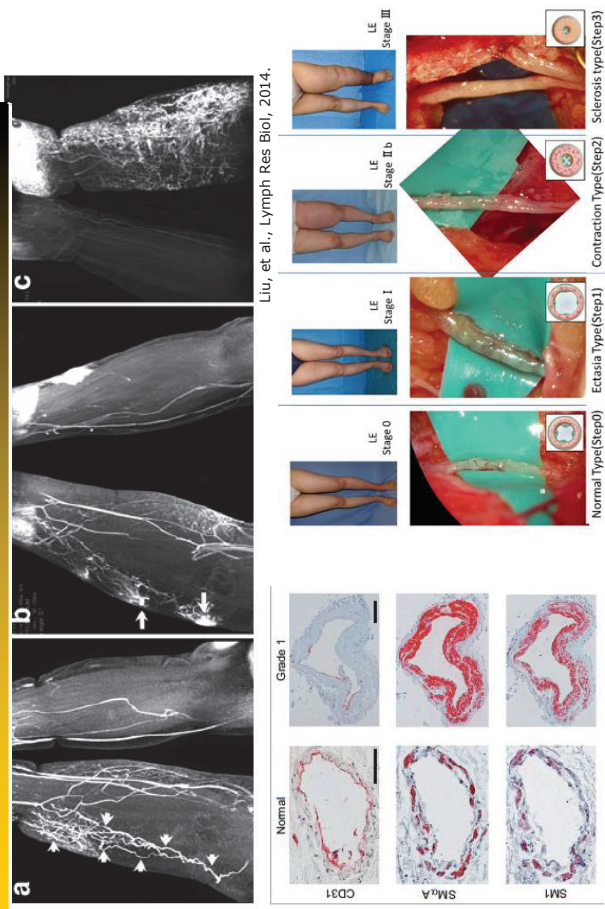
Lymphangions Drive Lymph Flow



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



Lymphatics Remodel During Lymphedema



Imaging Lymphatic Function

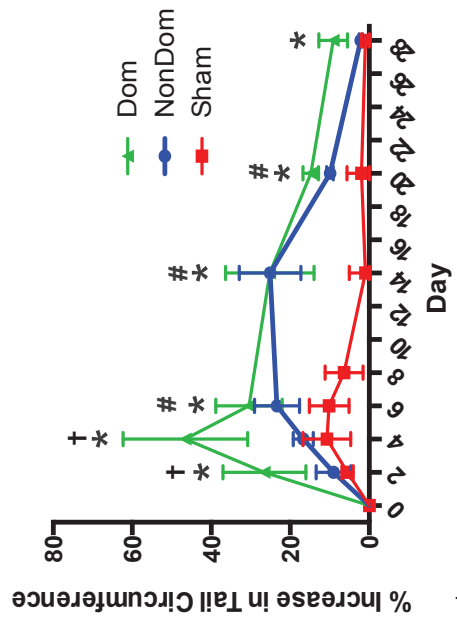
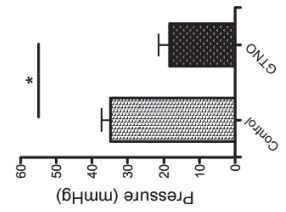
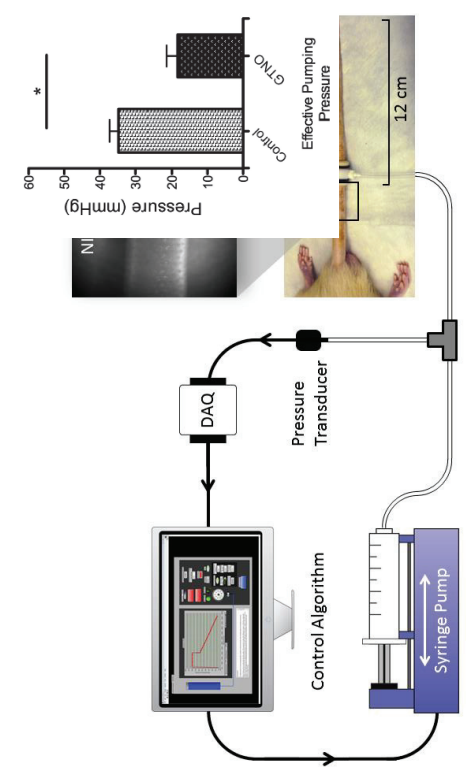
Isolated rat mesenteric vessel



Non-invasive NIR mouse tail lymphatic



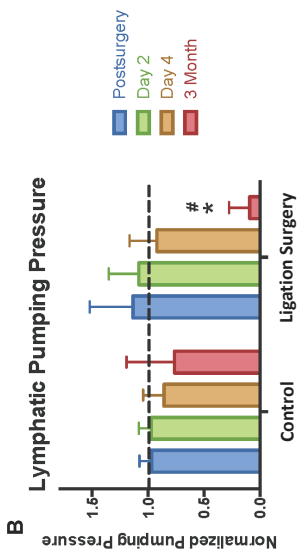
Lymphatic Pumping Pressure



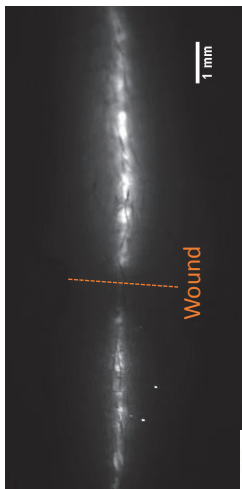
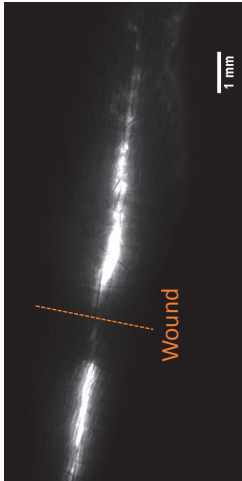
* = significant between Dom and Sham
 t = significant between Dom and NonDom
 # = significant between NonDom and Sham



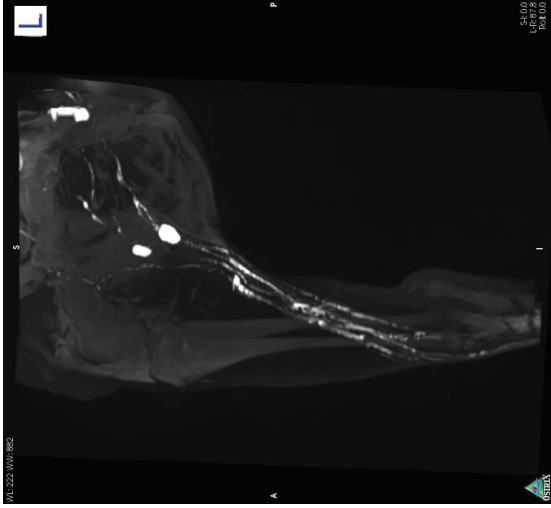
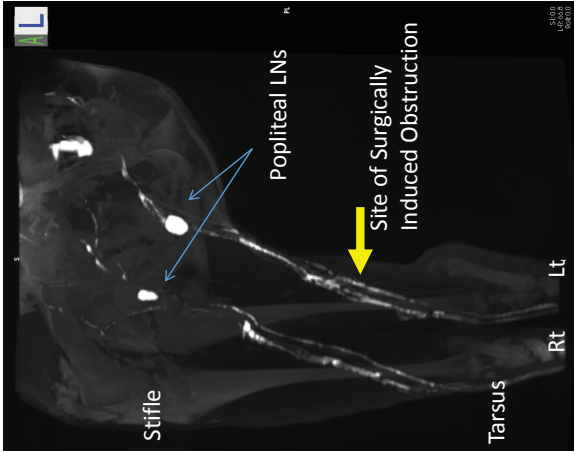
Pumping Pressure Loss in Surgery Model



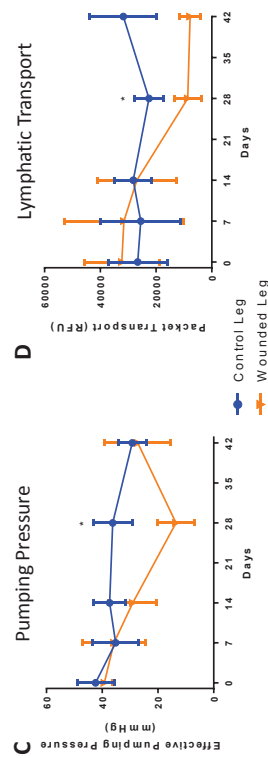
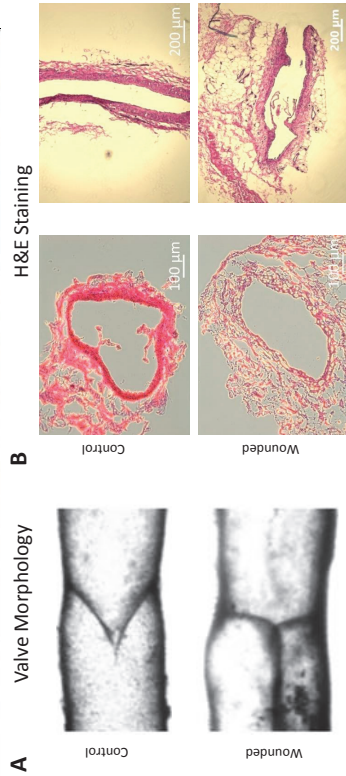
Ligation Surgery



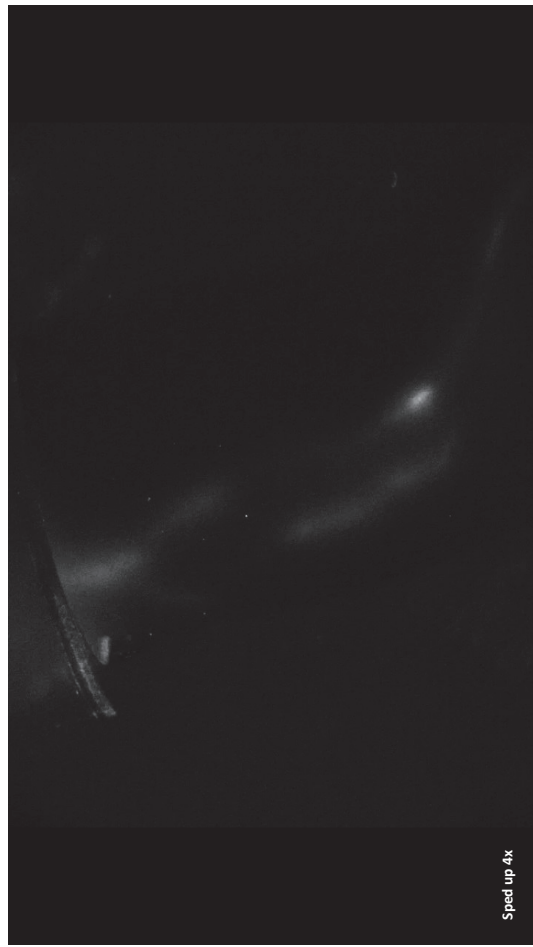
Sheep Model of Lymphatic Adaptation



Reduced Lymphatic Function Post-Surgery



Measuring Pumping Pressure in Humans

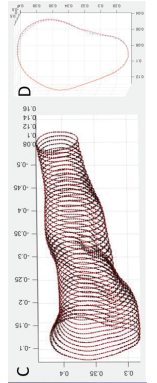
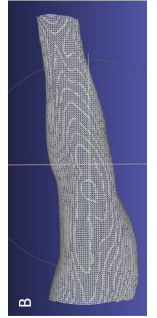
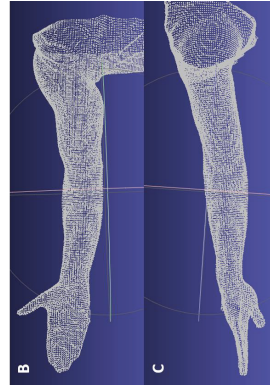
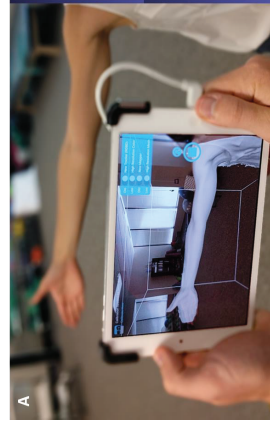


Transition Out of the Lab



13

High-Accuracy 3D Body Measurements

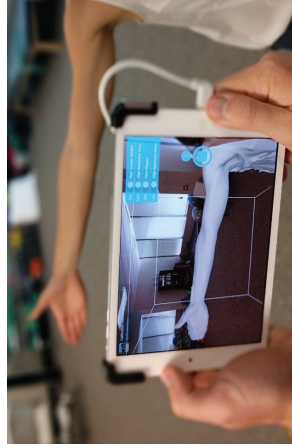


15

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

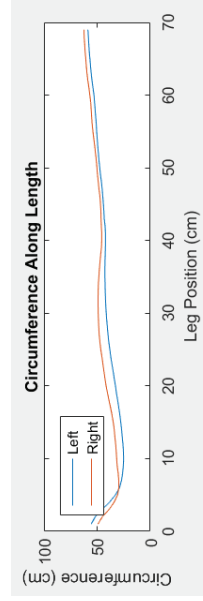
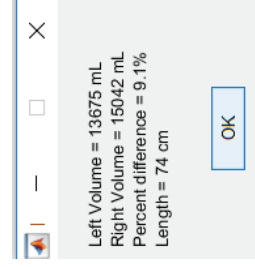
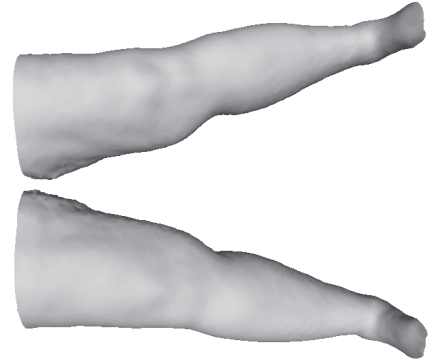


Patient profile tracks and trends impact of treatment



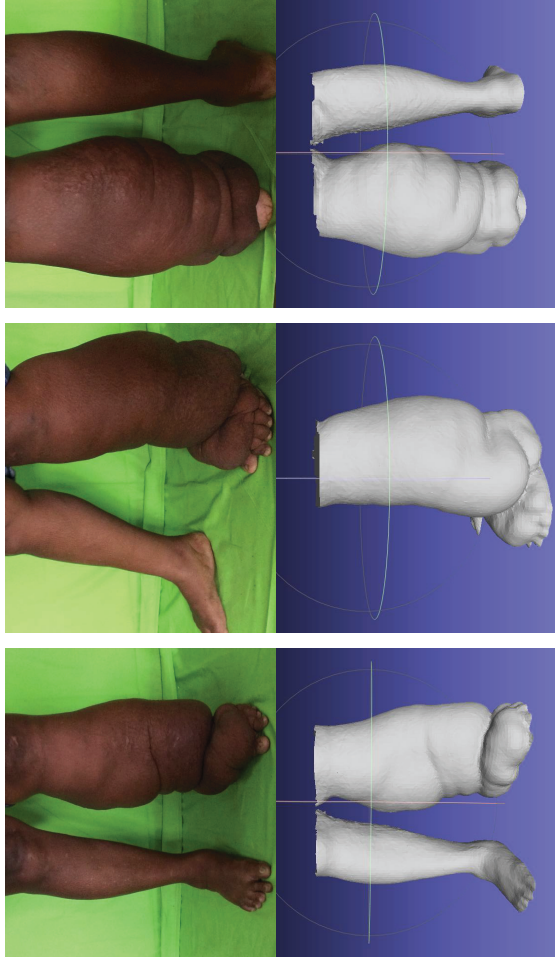
14

Solution Enhanced Geometry Measurements and Tracking

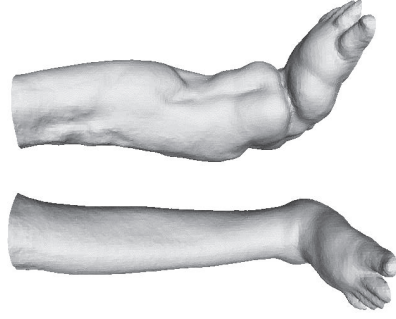


4

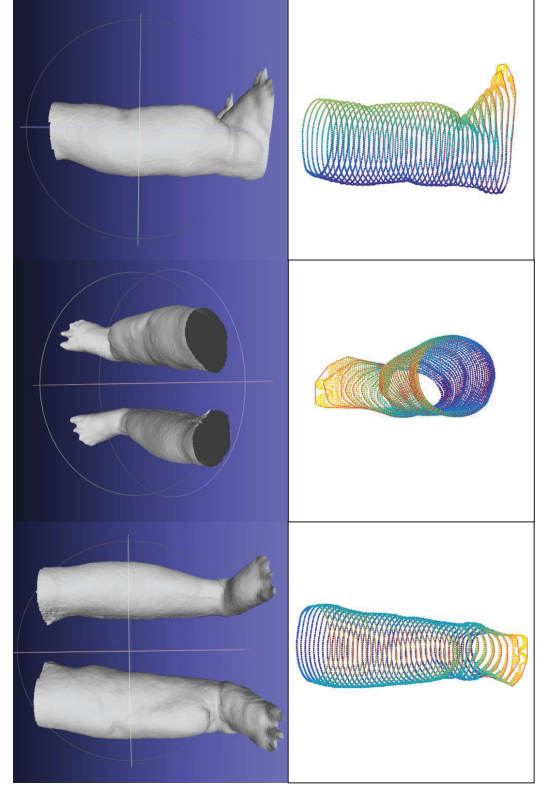
High-Resolution 3D Scans



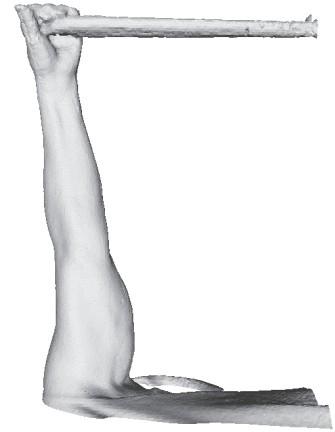
Leg Scan Example



Solution Enhanced Geometry Measurements



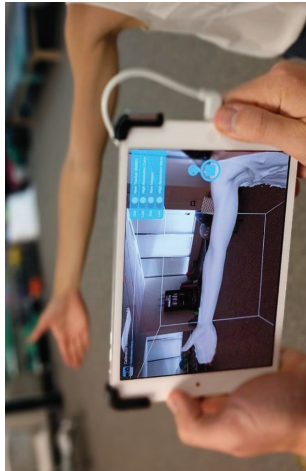
Arm Scan Example



Study #1: Validation of Arm Measurements in BC Patients

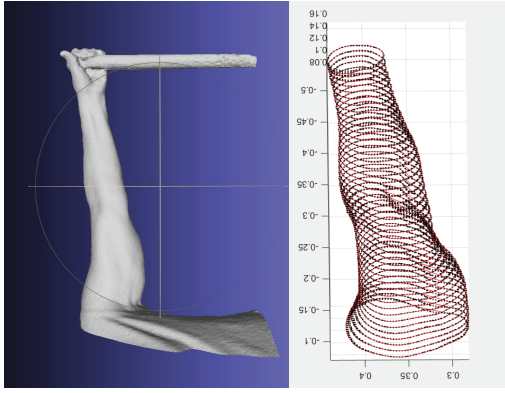
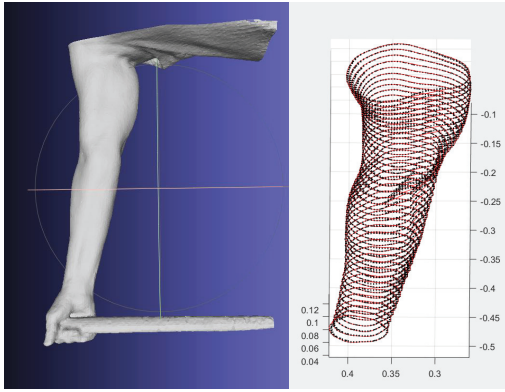


- 250+ total patients scanned over 2 year development period
- 50+ patients scanned with LymphTech system and Perometer for comparison
- 2 repeats of each scan to measure intra-operator variability of each technique

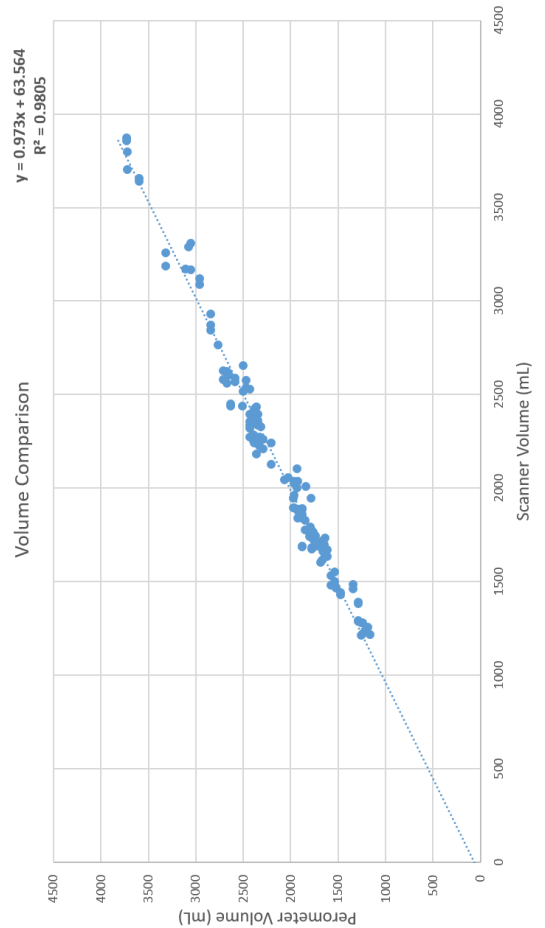


TurningPoint
Breast Cancer
Rehabilitation

Arm Scanning Automatic Segmentation from Wrist to Axilla



Validation Results Volume – Perometer



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



USAID
FROM THE AMERICAN PEOPLE

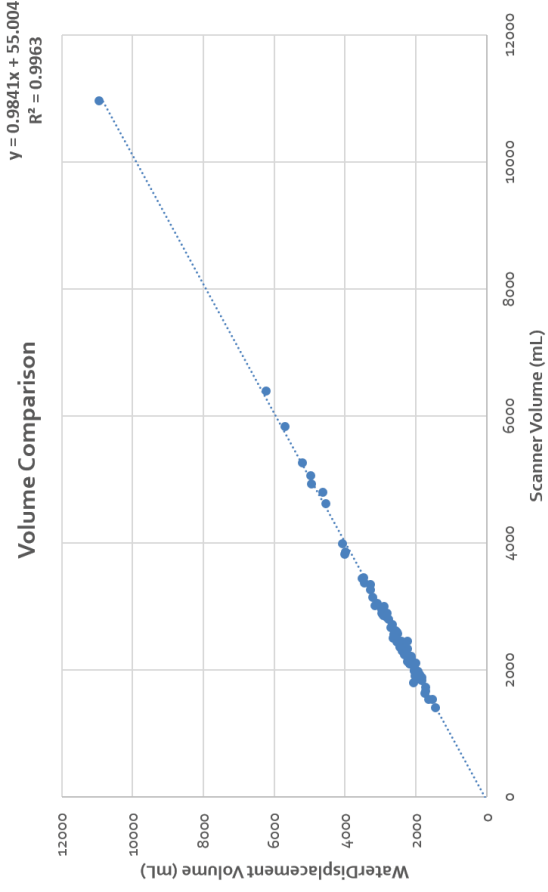


Filariasis Validation Study Protocol

- 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



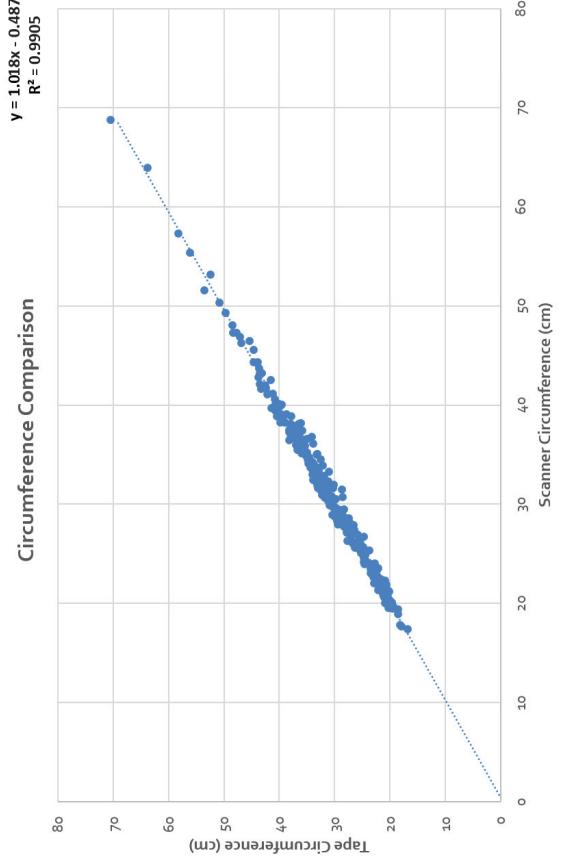
Validation Results Volume – Water Displacement



Validation Results Circumference – Tape Measure

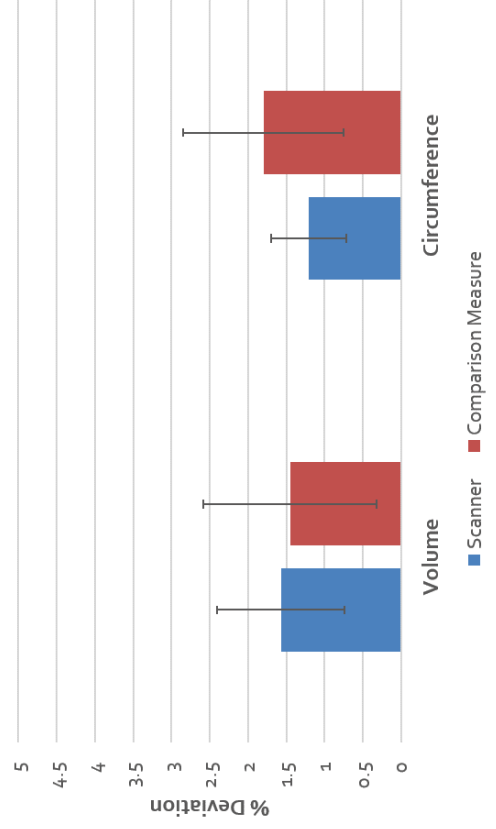
$$Y = 1.018x - 0.4876$$

$$R^2 = 0.9905$$



Validation Results Inter-operator Variability

Interoperator Variability Comparison



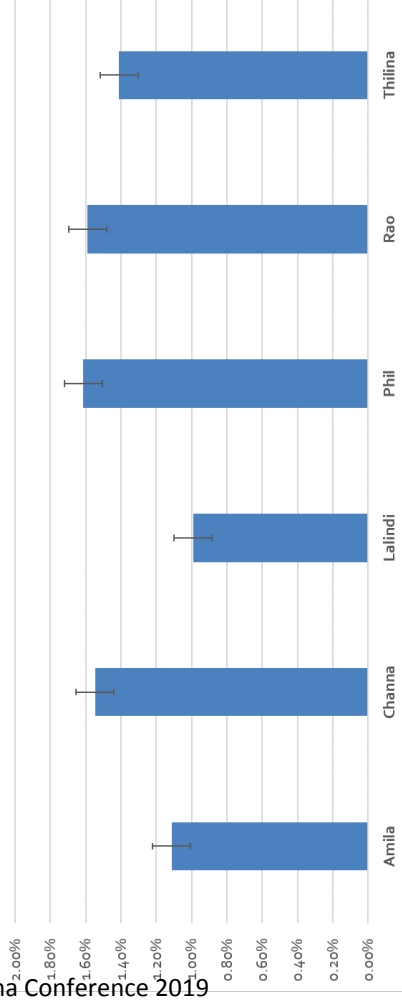
Validation Results Intra-operator Variability



LymphTech

Cumulative Intra-operator Variability = 1.38%

Intraoperator Variability



Current Status of Project



LymphTech



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, Wei G, Budge PJ. Use of a Novel Portable Three-Dimensional Scanner to Measure Limb Volume and Circumference in Patients with Filariasis Lymphedema. Published online October 16, 2017. DOI:10.4269/ajtmh.17-0504.



USAID
FROM THE AMERICAN PEOPLE

BILL & MELINDA
GATES foundation



Study #3: Validation of Longitudinal Measurements in Lymphedema Patients



LymphTech

- > 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



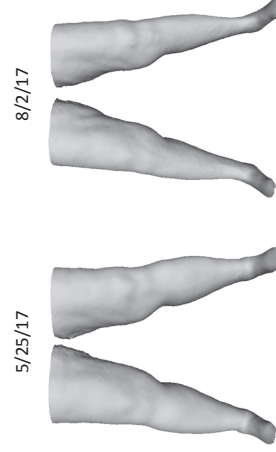
Hamilton
Health Care System

BenchMark
PHYSICAL THERAPY

Validation Results Longitudinal Volume and Circumference Tracking

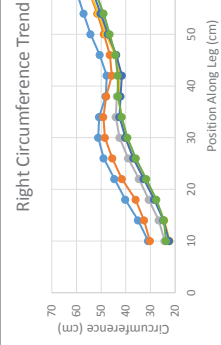
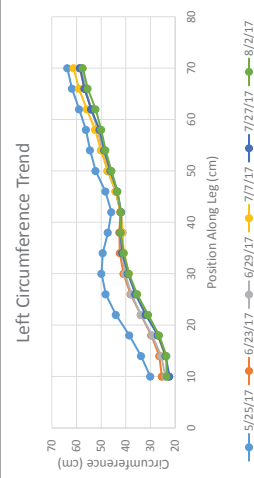
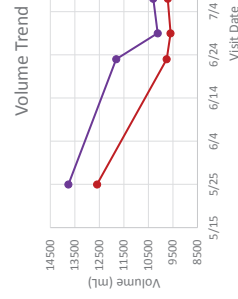


LymphTech

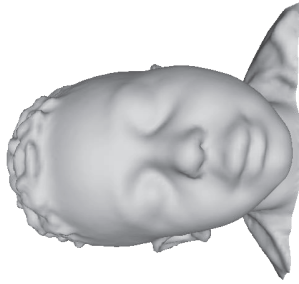


8/2/17

5/25/17



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

TurningPoint
Breast Cancer
Rehabilitation

Benchmark
PHYSICAL THERAPY



GEORGIA
RESEARCH
ALLIANCE



Washington
University in St. Louis



USAID
FROM THE AMERICAN PEOPLE



RICE
BUSINESS PLAN
COMPETITION



NEW VENTURE CHAMPIONSHIP



THE TASK
FORCE FOR
GLOBAL
HEALTH



Advancing Lymphedema Technologies