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Validity of the Body Scan Scanner® and Structure Sensor to Measure Limb Volume in Healthy Adults

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Background

Secondary lymphedema is a chronic condition that can develop in approximately 30 percent of women treated for breast cancer. Common clinical measures carry concerns of infection control (water displacement), are time consuming (truncated cone calculation using circumferential measures), or expensive (perometry). Use of a portable 3-dimensional (3D) scanner addresses these concerns, but the validity is unknown.

Purpose

The purpose of this phase I study is to investigate the validity of the Body Scan Scanner® and Structure Sensor to measure limb volume in healthy volunteers.

Participants

A convenience sample of 6 female and 9 male adults with a mean age of 23 (range 22-25) years and BMI 23.99 kg/m² without any medical conditions resulting in limb swelling.

Methods

Participants underwent the measurement of limb volume bilaterally (30 limbs) with 3D infrared scanning using the Body Scan Scanner® (TechMed 3D, Montreal, ON, Canada) and the Structure Sensor (occipital, San Francisco, CA). Limb volume for both 3D images were calculated using MSoft 3.0 (TechMed 3D, Montreal, ON, Canada). The reference standard was water displacement. Descriptive statistics for age and body mass index (BMI) were calculated. Intraclass correlation coefficients were calculated for the 3 measures of limb volume. Repeated measures ANOVA was used to examine mean differences between measures.



Body Scan Scanner (Left) & Structure Sensor (Right)

Results

The correlation matrix for the left and right limb show ICC values >.90 for all measures (Table 1, Table 2).

The ANOVA of volume measures was significant ($p<0.001$) with Bonferroni *post hoc* testing showing that the Structure Sensor measures were significantly different from both water displacement ($p<0.001$) and the Body Scan Scanner® ($p<0.001$).

Table 1: ICC for Left Limb Volume Measures

LEFT LIMB	Water Displacement	Body Scan Scanner®	Structure Sensor
Water Displacement	1.000	.990	.985
Body Scan Scanner		1.000	.982
Structure Sensor			1.000

Table 2: ICC for Right Limb Volume Measures

RIGHT LIMB	Water Displacement	Body Scan Scanner®	Structure Sensor
Water Displacement	1.000	.992	.988
Body Scan Scanner		1.000	.991
Structure Sensor			1.000

Table 3: Means (SD) Limb Volume Measures (ml)

Water Displacement		Body Scan Scanner®		Structure Sensor	
Left	Right	Left	Right	Left	Right
1862 (±407)	1916 (±458)	1929 (±392)	1960 (±448)	2034 (±459)*	2270 (±536)*

*significance $\alpha\leq 0.05$



Demonstration of use and participant placement for use of Body Scan Scanner

Discussion

All 3D imaging volume measurements correlate strongly with water displacement measures. The Structure Scanner overestimates limb volume compared to other measures. Future studies should look at the reliability of the 3D imaging in measuring the limb volumes of individuals with secondary lymphedema

Conclusion

The limb volume measurements taken with the 3D Body Scan Scanner® and Structure Sensor could provide a more efficient way to measure limb volume in healthy individuals

Clinical Relevance

Portable 3D scanning shows promise to be a valid and efficient method to measure limb volume. Further research to determine responsiveness to change in individuals with secondary lymphedema is needed.

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Scan of limb with portion marked for volume measurement

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