Validation of a 3D Laser Scanner Structure Sensor to measure upper extremity circumferences: potential clinical implications for lymphoedema rehabilitation.

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Background

Upper limb volume assessment is the first step in lymphedema diagnosis and rehabilitative management [1]. Circumferential method (CM), the most commonly used limb volumetric method, showed several limitations in common clinical rehabilitation practice and recently new methods using three-dimensional laser scanning (LS3D) have been proposed for limb volume measurement, even in the worst stages of lymphedema [2-4]. Aim of this study was to verify the reproducibility and reliability of LS3D compared to CM in upper limb volume measurement in healthy young adults and in breast cancer related lymphedema (BCRL) women.

Table 1. Inter-operator analysis of circumferential method

	OPERATOR A	OPERATOR B	MEAN
V forearm	1.04 ± 0.24	1.04 ± 0.24	1.04 ± 0.24
V arm	0.92 ± 0.26	0.92 ± 0.26	0.92 ± 0.26
V tot	1.96 ± 0.47	1.96 ± 0.47	1.96 ± 0.47

Means and standard deviations of volumetric parameters by the Operator A, Operator B and Inter-operator mean (dm³)

Table 2. Inter-operator analysis of Laser Scanner 3D method

	OPERATOR A	OPERATOR B	MEAN
V forearm	1.02 ± 0.25	1.02 ± 0.25	1.02 ± 0.25
V arm	0.89 ± 0.26	0.90 ± 0.26	0.89 ± 0.26
V tot	1.91 ± 0.48	1.91 ± 0.49	1.91 ± 0.49

Means and standard deviations of volumetric parameters by the Operator A, Operator B and Inter-operator mean (dm³)

Methods

Healthy young adults, without diseases altering upper limb volume and BCRL patients were enrolled in the Physical and Rehabilitative Medicine Service, University Hospital "Maggiore della Carità", Novara, Italy. Two raters performed both LS3D (Figure 1) and centimetric upper limb volume evaluation twice in each subject. Each procedure duration was measured.

Results

Thirty healthy young adults (14 male and 16 female), mean aged 27.6±9.8 years with a mean BMI of 22.7±2.9 kg/m² were enrolled. Both LS3D and CM showed a significant inter-operator (Tables 1 and 2) and intra-operator correlation in upper limb volume measurement ($r^2=0.99$; $p<0.0001$). Moreover LS3D showed a strong correlation with CM ($r^2=0.99$; $p<0.0001$) (Figure 2).

LS3D was significantly quicker in upper limb volume measurement than CM (202±27 sec. vs 293±17 sec; $p<0.0001$). In the preliminary analysis performed on 4 women affected by BCRL, LS3D showed the same inter and intra-operator correlation than in healthy subjects ($r^2=0.99$; $p<0.0001$).

Conclusions

LS3D Structure Sensor is a highly reproducible, reliable and easy to use method to evaluate upper limb volume in healthy subjects. These results combined with the preliminary ones obtained in BCRL patients suggest its potential use in lymphedema common clinical rehabilitation practice.

Figure 1. Example of use of the laser scanner 3D method (LS3D).

Figure 2. Correlation between laser scan 3D and circumferential method.

Bibliografia

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