Reliability, concurrent validity and time-efficiency of measurement methods assessing volume in patients with lower limb lymphoedema and healthy controls

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Introduction: Of all different measurement methods that are currently available for use in clinical practice for the assessment of lower limb swelling, a clear overview regarding reliability, concurrent validity and time-efficiency is missing[1]. Also, in previous studies in patients with lower limb lymphoedema (LLL), the day-to-day (or between-session) reliability of the measurement procedures has rarely been quantified[2]. Thus, it is unclear whether or not the current lack of consistent findings is due to measurement error associated with day-to-day variability in limb volume resulting from normal activities of daily living, or not.

Aim: To investigate reliability (intra-rater, inter-rater, and between-session), concurrent validity and time-efficiency of measurement methods evaluating volume of the leg (circumference measures leg using a perimeter after which volume was calculated, opto-electronic volumetry) and volume of the foot (water displacement, figure-of-eight circumference), in patients with LLL and healthy controls.

Method: A cross-sectional study with exploratory design has been performed in the University Hospitals of Leuven, Belgium. Participants were recruited between February and November 2022. To investigate reliability, participants were evaluated three times with each evaluation method: two times by the same assessor and a third time by a second assessor. Patients and controls were evaluated two times by the same assessor over a time span of 2 weeks to investigate between-session reliability. To investigate intra- and inter-rater reliability and between-session (or day-to-day) reliability, intraclass correlation coefficients (ICCs), standard errors of the measurement (SEMs) and systematic differences between the means were calculated. To determine concurrent validity, the measurement methods assessing the same oedema characteristic (resp. volume leg and volume foot) were correlated to each other using a Spearman correlation coefficient. Lastly, time efficiency was examined for each of four methods.

Results:

Intra-rater (within-session) reliability for evaluating leg swelling (total volume in ml) was very strong for circumference measures both in patients (ICCintra 0.986, n=75) as in healthy controls (ICCintra 0.997, n=60). Opto-electronic volumetry showed strong reliability in patients (ICCintra 0.833, n=75) and very strong reliability in healthy controls (ICCintra 0.998, n=58). Intra-rater (within-session) reliability for evaluating swelling of the foot (total volume in ml) was very strong for the figure-8 method both in patients (ICCintra 0.984, n=75) as in healthy controls (ICCintra 0.988, n=60). Water displacement showed weak reliability both in patients (ICCintra 0.132, n=75) as in healthy controls (ICCintra -0.027, n=60).
Inter-rater reliability (within-session) showed similar results, despite water displacement showing very strong reliability in healthy controls this time (ICCinter 0.975, n=60).
Intra-rater (between-session) reliability showed very strong reliability for all measurement methods (ICCbetween-session >0.900), both in patients (n=47) as well as in healthy controls

(n=42).
• A significant strong (r=0.815; p<.001) and very strong (r=0.904, p<0.001) association were found between total leg volume measured by circumferences (ml) versus total leg volume measured by the opto-electronic volume device (ml) in resp. patients and healthy controls. Between the figure-8 method and water displacement of the foot, significant moderate associations were found, both in patients (r=0.517, p<0.001) and healthy controls (r=0.534, p<0.001).
• For measuring leg swelling, the opto-electronic volumetry device was the fastest (mean execution time of 1min and 25,10sec). For measuring swelling of the foot, the figure-8 method was the fastest (mean execution time of 1min and 42,24sec).

Conclusion: Evaluation of volume of the leg and foot showed strong to very strong intra-rater, inter-rater, and between-session reliability, both in patients with LLL as in healthy controls. Water displacement at the level of the foot showed weak intra-rater reliability and took more than 10 minutes of time for a bilateral assessment.

References

(1) The diagnosis and treatment of peripheral lymphedema: 2020 Consensus Document of the International Society of Lymphology. Lymphology. 2020;53(1):3-19
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