

Evidence Summary: Lymphoedema: Objective assessment using circumference measurement

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QUESTION

What is the best available evidence on circumference measurement to assess lymphoedema?

SUMMARY

Of the various objective and subjective strategies to assess lymphoedema, circumference measurement has the greatest utility in clinical practice, with demonstrated validity and reliability of measurement and greatest accessibility for most clinicians.^{1,2} (Level 1.b evidence)

BACKGROUND

Lymphoedema is a form of chronic, progressive oedema in which there is significant, persistent swelling of a limb or other body region due to excess and abnormal accumulation of protein-rich fluid in body tissues. This fluid contains a range of inflammatory mediators and adipogenic factors.³⁻⁷ The lymphatic system is unable to manage the volume of accumulated fluid.⁶

Lymphoedema occurs due to primary, secondary or mixed causes. Primary causes are described as congenital (e.g. an inherited disorder such as Milroy's disease), praecox (onset at puberty, e.g. Meig's disease) or tarda (sudden onset no apparent cause).⁸⁻¹⁰ Secondary causes arise from direct damage or trauma to the lymphatic system such as injury, surgery or radiotherapy (usually related to treatment of breast cancer), or parasitic invasion.⁹⁻¹¹ Lymphatic filariasis (also called elephantitis) is a cause of secondary lymphoedema in endemic areas primarily in Africa and Asia. Lymphatic filariasis is a parasitic (roundworm) infection that is spread by mosquitoes and causes damage to the lymphatic system that may result in lymphoedema. Infection generally occurs in childhood. Management focuses on large-scale treatment programs to reduce disease spread.^{7, 12} Mixed lymphoedema describes lymphoedema arising from decompensation or failure of the lymphatic system associated with other disease or conditions, including but not limited to obesity, immobility, venous disease or lipodema.^{9, 10, 13}

Without management, lymphoedema may lead to:^{6, 14}

- progressive swelling,

- superficial tissue changes – increasing adiposity and fibrosis,
- physical and functional limitations,
- chronic infection,
- lymphorrhoea (leaking of lymph fluid),
- pain and discomfort, and
- reduced ability to undertake activities of daily living (ADL's)

Comprehensive assessment of lymphoedema includes objective measures of volume/size, and subjective assessment of signs and symptoms, including their impact on the patient.¹⁵ In patients with mixed lymphoedema, it is also important to assess factors associated with the underlying disease or condition (not addressed in this evidence summary).

This evidence summary presents evidence related to the reliability and validity of one objective measurement used to assess lymphoedema: circumference measurement.

Circumference measurement involves measuring around the oedematous limb using a measurement tape.⁶ Circumference measurement, which is the most commonly used strategy for diagnosis and assessment of lymphoedema,⁴ is reported to be both the easiest and most cost-effective strategy to assess limb size.^{1,2}

CLINICAL BOTTOM LINE

Circumference measurement

Performing circumference measurement

- There is no standard position in which measurement should be performed.² (Level 1.b evidence)
- It is recommended that the measurement tape be applied perpendicular to the limb and with a consistent tautness.² (Level 1.b evidence)
- Defined distances along the limb are used as the measurement points (e.g. every 2 to 10 cm). There is no standard distance used between measurement points; however the chosen distance should be consistent between repeated measures.^{2, 3, 6} (Level 1.b evidence)

- Using easily identifiable anatomical landmarks as the point to perform measurements is also reported,¹⁶ but this strategy does not appear to be more accurate.² (Level 1.b evidence). The following landmarks have been recommended for arm circumference measurements:
 - midpoint of the upper arm¹⁶
 - superior border of the olecranon¹⁶
 - midpoint of the forearm¹⁶
 - 10cm below the elbow¹¹
 - 10cm below the elbow¹¹

- Limb volume can be estimated using circumference measures using either the truncated cone formula or cylinder formula (N.B this measurement is an estimation only, and is not inter-changeable with a measured limb volume¹⁷). The commonly used truncated cone formula is:^{2, 17, 18}

$$\text{Volume} = \frac{L(X^2 + XY + Y^2)}{12\pi}$$

Where: L = length of the segment along the arm

X = the circumference at the bottom of the segment

Y = the circumference at the top of the segment.

Calculate the volume of each segment and add them to determine the volume of the entire limb.

- For all measures of limb size and/or volume, comparison should be made with:^{15, 18}
 - a pre-condition measurement of the affected limb (where available) to determine severity of lymphoedema,
 - the unaffected limb to determine severity, and
 - the affected limb over time to objectively assess the effectiveness of the management plan.
- A 2 cm circumference difference in limb circumference is commonly used as a diagnostic cut-off point.³ (Level 5.c evidence)

Reliability of circumference measurement

- In one validation study involving patients with breast cancer associated lymphoedema (n=14), arm circumference measures were taken at the upper arm, the elbow and forearm. Both intra-rater (2 measurements) and inter-rater (2 raters) reliability were excellent for circumference measurements at all three anatomical sites (intra-class coefficient [ICC]>0.90, p<0.05 for all comparisons). Standard error of measurement (SEM) ranged from 0.5% to 1.3% (0.13 to 0.21 cm), with error being slightly greater for measurements at the elbow.¹⁶ (Level 3.e evidence)

- In one study, inter-rater reliability (two raters) of circumference measurements at anatomical positions selected based on bony landmarks was excellent (ICC=0.97 to 0.99) in both women with (n=19) and without upper limb lymphoedema (n=22).¹⁸ (Level 3.c evidence)
- In one cohort study (n=51) circumference measurements were made at four points along the arm, and estimated limb volume was calculated. There was good reliability in arm volume estimation in women with lymphoedema (n=33, ICC=0.98, 95% confidence interval [CI] 0.96 to 0.99, standard error 94 ml) and in women without lymphoedema (n=18, ICC=0.98, 95% CI 0.95 to 0.99, standard error 54ml). There was a significant concordance with perometry measures (p<0.001) and bioimpedance spectroscopy (p<0.001).¹⁷ (Level 3.c evidence)
- In another cohort study there was excellent inter-rater reliability (two raters) in calculations of estimated upper limb volume in women with (n=19) and without (n=22) lymphoedema (ICC = 0.95 to 0.98). The estimated calculation of volume was approximately 5% above that measured using water displacement; however the difference was not significant.¹⁸ (Level 3.c evidence)
- In a retrospective cross-sectional study conducted with women with (n=70) and without (n=71) upper limb lymphoedema, volume estimate based on circumference measurement was found to have higher accuracy (area under curve [AUC]=0.82 to 0.83, p<0.001) than circumference measurement alone (AUC=0.66 to 0.79, p<0.001).¹⁹ (Level 4.b evidence)

Figure-of-eight circumference measure

A figure-of eight measurement of the hand has also been used to measure the degree of hand swelling. A measuring tape is passed across the hand and around the wrist, and measures swelling in the hand region. Although the method incorporates measurement of more hand proportions in one measurement, limitations such as the tautness of the tape are not overcome.²⁰

- One study evaluated reliability of figure-of eight measuring compared to volumetry in 25 participants with hand swelling associated with breast cancer treatment. Two novice and blinded testers performed the figure-of-eight measurements after a one hour training session. Intrarater reliability was excellent for both testers (ICC>0.800) and intra-rater reliability was excellent (ICC>0.800) compared with volumetry. There was a statistically significant correlation between the two measurement methods (r=0.700 to 0.752, p<0.001).²⁰ (Level 3.e evidence)

Limitations of circumference measurement

- The measurement method is unable to distinguish between muscle, bone, fat and fluid.²
- Difficulty identifying and consistently using the same site for location measurement,^{3, 6, 20} leading to inaccurate ongoing comparison of change in measurement.¹⁶

- Failure to ensure there is no slack in the tape, leading to over measurement.¹⁶
- Potential to create indentation in the tissue, leading to under measurement.¹⁶

CHARACTERISTICS OF THE EVIDENCE

This evidence summary is based on a structured literature and database search combining search terms that describe lymphoedema and assessment. The evidence in this summary comes from:

- Systematic reviews of studies of various design^{2, 4} (Level 1.b evidence)
- Cohort studies with control groups^{17, 18} (Level 3.c evidence)
- Observational studies with no control group^{11, 15, 16, 20} (Level 3.e evidence)
- A retrospective cross-sectional study¹⁹ (Level 4.b evidence)
- Case series report¹³ (Level 4.c evidence)
- Expert consensus^{7, 9} (Level 5.b evidence)
- Expert opinion^{1, 3, 5, 6, 8, 10, 12, 14} (Level 5.c evidence)

BEST PRACTICE RECOMMENDATIONS

Circumference measurement is a reliable and valid strategy for assessing the presence and degree of lymphoedema. (Grade A).

Related Evidence Summaries

JB1 10912 Identification of people at risk of venous leg ulcers

JB1 11559 Lymphedema: classification

JB1 11564 Lymphedema: objective assessment using bioimpedance spectroscopy

JB1 11562 Lymphedema: objective assessment using perometry

JB1 11560 Lymphedema: subjective assessment

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