

Evidence Summary: Lymphoedema: Objective assessment using bioimpedance spectroscopy

June 2014

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QUESTION

What is the best available evidence on bioimpedance spectroscopy to assess lymphoedema?

SUMMARY

Bioimpedance spectroscopy measures the resistance (impedance) of body tissue to electrical current flow to assess changes in fluid volume associated with lymphoedema^{1,2}. This assessment strategy is valid, and well-correlated with other objective measures of lymphoedema (for example, circumference measurement)^{1,3} (Level 1.b evidence); however, the resources may not be available in all clinical settings.

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 tissues⁴⁻⁸. This fluid contains a range of inflammatory mediators and adipogenic factors. The lymphatic system is unable to manage the volume of accumulated fluid⁷.

Lymphoedema occurs due to primary, secondary or mixed causes. Primary causes are described as congenital (for example, an inherited disorder such as Milroy's disease), praecox (onset at puberty, for example, Meigs' disease) or tarda (sudden onset no apparent cause)⁹⁻¹¹. 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 invasion¹⁰⁻¹². 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, although. Management focuses on large-scale treatment programs to reduce disease spread^{8,13}. 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 lipoeedema^{10,11,14}.

Without management, lymphoedema may lead to^{7,15}:

- progressive swelling
- superficial changes — increasing adiposity and fibrosis
- physical and functional limitations
- increased risk of chronic infection
- lymphorrhoea (leaking of lymph fluid)
- pain and discomfort

- reduced ability to undertake activities of daily living (ADLs).

Comprehensive assessment of lymphoedema includes objective measures of volume/size, and subjective assessment of signs and symptoms, including their impact on the patient¹⁶. 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: bioimpedance spectroscopy.

Bioimpedance spectroscopy measures the resistance (impedance) of body tissue to electrical current flow. A small electrical current is passed through the body using skin electrodes and voltage drops between the electrodes provides a measure of the tissue resistance. At low frequencies the electrical current is able to pass through only extracellular fluid (that is, it cannot penetrate cell membranes) while at higher frequencies the current passes through both intracellular and extracellular fluid. The results are compared with prediction equations to estimate extracellular fluid differences (usually between limbs in uni-lateral lymphoedema)^{1,2}.

CLINICAL BOTTOM LINE

Performing bioimpedance spectroscopy

- The patient is positioned supine on a nonconductive bed/table or seated in a nonconductive chair with arms extended and forearms pronated³.
- Standardised electrode positioning is used³.
- For all measures of limb size and/or volume, comparison should be made with^{1,16}:
 - a pre-condition measurement (where available) of the affected limb to determine severity of lymphoedema,
 - the unaffected limb (when available) to determine severity, and
 - the affected limb over time to objectively assess the effectiveness of the management plan.

Reliability of bioimpedance spectroscopy

- In one cohort study (n=51) bioimpedance spectroscopy was compared to perometry and circumference measurements to estimate upper limb volume. There was good reliability in inter-limb comparisons in women with lymphoedema (n=33, ICC=0.95, 95% CI 0.91 to 0.98, standard error 0.06). There was a significant concordance with perometry measures (p<0.001) and circumference measurements (p<0.001)¹. (Level 3.e evidence)

- One systematic review of ten studies conducted with women following breast cancer treatment reported that bioimpedance spectroscopy has a strong correlation with circumference measurements ($r=0.89$ to 0.99) and with perometry ($r=0.919$)³. (Level 1.b evidence)

Limitations of bioimpedance spectroscopy

- Requires specialised equipment and individual-use electrodes³.
- Access is limited in many clinical locations¹⁶.

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^{3,5} (Level 1.b evidence)
- Cohort study with control groups¹ (Level 3.c evidence)
- Observational studies with no control group^{12,16} (Level 3.e evidence)
- Case series report¹⁴ (Level 4.c evidence)
- Expert consensus^{8,10} (Level 5.b evidence)
- Expert opinion^{4,6,7,9,11,13,15} (Level 5.c evidence)

BEST PRACTICE RECOMMENDATIONS

There is some evidence that bioelectrical impedance spectroscopy is a valid strategy for assessing the presence and degree of lymphoedema. (Grade B).

Related topics

JB1 Evidence Summary 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 11870 Lymphedema: objective assessment using tonometry

JB1 11871 Lymphedema: objective assessment using volumetry

JB1 12020 Lymphedema: objective assessment using circumference measurement

JB1 11560 Lymphedema: subjective assessment

JB1 12096 Managing lymphedema: pneumatic compression therapy

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