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# MoistureMeter D

## Local measurements of tissue water


# MoistureMeterD

- Measures tissue water content at different layers of skin locally and non-invasively
- Measurement depth determined by the probe size
- Data collection wirelessly into Delfin Modular Core software

# MoistureMeterD Compact

- Fully portable
- Excellent in hospitals, public and private health care centers
- Skin water content measurement by integrated probe
- Built-in pressure sensor for user independent measurements


- Displays tissue water content in percent (0 - 100 %)
- Rechargeable battery
- Wireless data collection with Delfin Modular Core software

# MoistureMeterD

Extremely useful in detecting physiological reactions in the skin and fat layer caused by tissue fluid changes

- Increase or reduction of edema
- Increase of blood flow
- Irritation reaction
- Water changes caused by enhanced active
- Ingredients penetration
- Effect of treatments (medication, lymph therapy, personal care products)
- Long term or transient effect

# MoistureMeterD devices

## Measurement principle

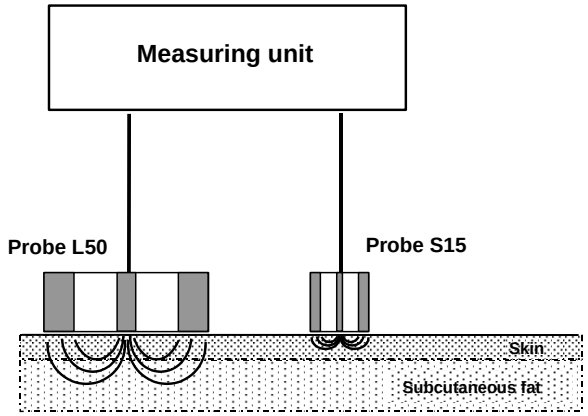
Interaction of 300 MHz low power electromagnetic waves with tissue water molecules

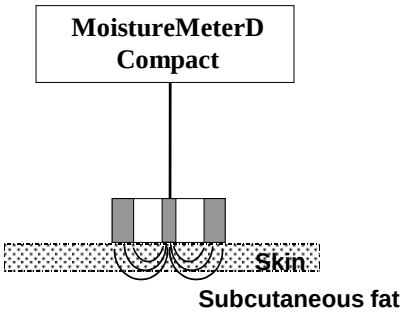
Portion of the EM energy is absorbed by tissue water

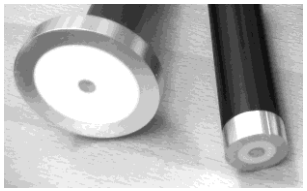
Reflected wave contains information on tissue water content

From reflected wave information **tissue dielectric constant** (TDC) can be determined.

**Tissue dielectric constant**
is proportional to
tissue water content



Probe L50 Probe S15

# MoistureMeterD

## Water specific measurement using 300 MHz radiofrequency

1. Extracellular space contains free water and bound (or motionally restricted) water molecules on the surface of macromolecules.

2. Dielectric constant of free water depends on radiofrequency.

   Electrical properties of free and bound water present in tissues change with frequency. At around 300 MHz, electrical properties of free and bound water are quite practically equal i.e. whole tissue water compartment is measured, (Pennock, Schwan: J Phys Chem, 1969)

3. MoistureMeterD devices (at 300 MHz) measure the tissue total water content (consisting of free and bound water).

# MoistureMeterD

## Simulation study for skin water and solid component using water-ethanol mixtures

- Dielectric constants of pure ethanol and pure water are 22 and 78.5, respectively
- Dielectric constants of mixtures of water and ethanol vary between 22 and 78.5
- Five different mixtures (percentage water volume content, V%) were prepared:

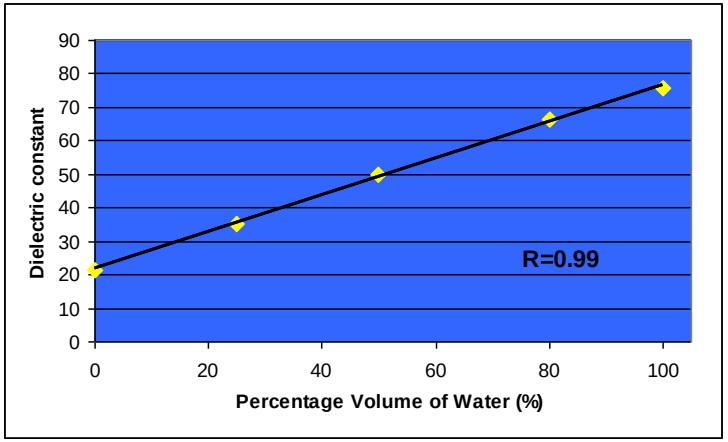
  V% = 0 % (pure ethanol)

  V% = 25 %

  V% = 50 %

  V% = 80 %

  V% = 100 % (pure water)



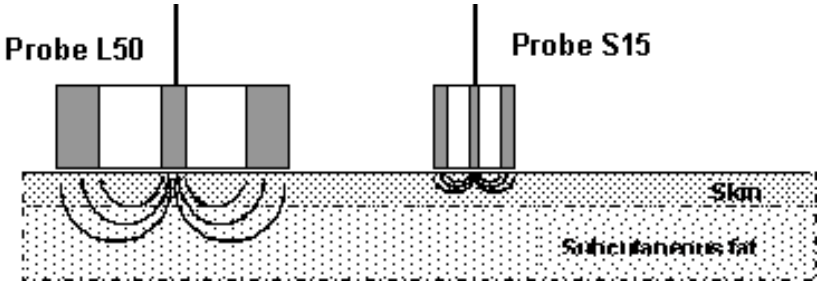

- The dielectric constants of mixtures were measured with the MoistureMeterD

# MoistureMeterD

## Dielectric constant and water content

- Dielectric constant of water = 78.5
- Dielectric constant of air = 1
- Dielectric constant of skin, typically 20 – 40
- Dielectric constant of human fat ≈ 10
- Tissue water dominates the measurement value due to its exceptionally high dielectric constant
- The deeper the measurement depth, the more adipose tissue included in the measurement field of the probes

$\Rightarrow$ the dielectric constant value decreases



# MoistureMeterD

## Selecting the probe size

| Probe | Effective measuring depth | Measures down to | Application examples |
|---|---|---|---|
| XS5 | 0.5 mm | 2.5 mm | Cosmetic products, transdermal drug penetration |
| S15 | 1.5 mm | 3 mm | Irritation reactions, wound healing, burns, transdermal drug penetration |
| M25 | 2.5 mm | 5 mm | Blood circulation, lymphedema, postoperative edema |
| L50 | 5 mm | 8 mm | Subcutaneous tissue metabolism, cellulite treatment |

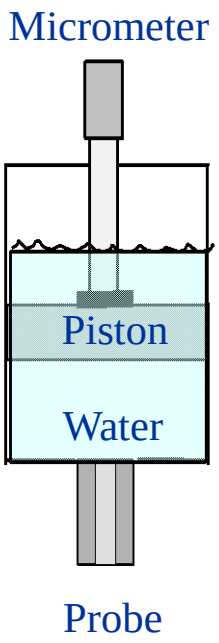

**OBS! MoistureMeterD Compact has an integrated probe corresponding to the MoistureMeterD probe M25!**

# MoistureMeterD

## Determining the measurement depth

An experimental two-layer model

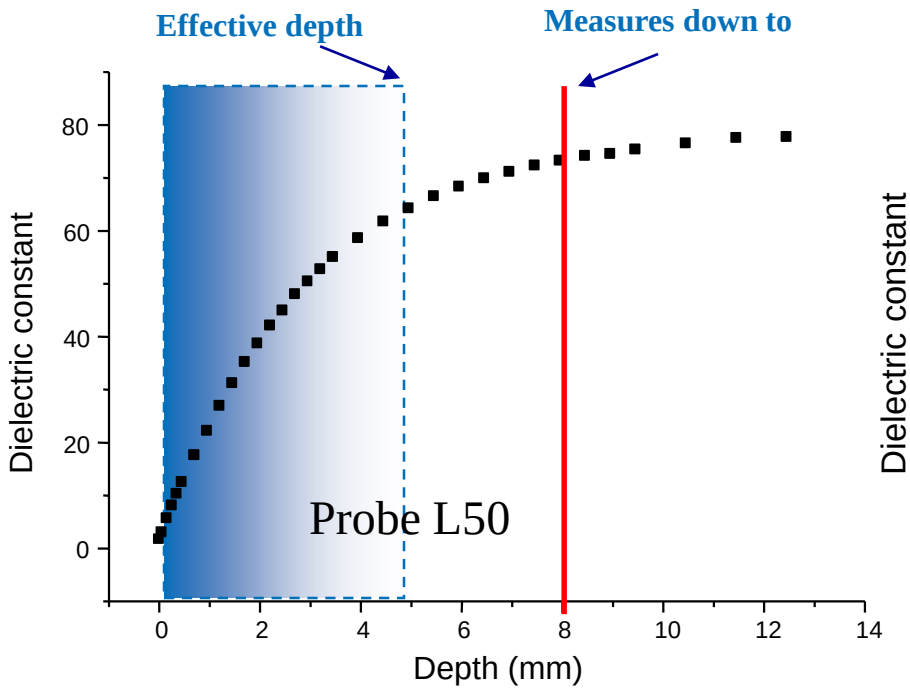
1. A cylindrical chamber with a micrometer-controlled movable acrylic piston filled with water
2. When the piston is in contact with the probe, the MoistureMeterD measures only the piston (dielectric constant = 3)
3. The piston is gradually moved away from the probe and the MoistureMeterD starts to measure the total dielectric constant of the combination of water and the piston and the value increases
4. When the piston is far enough from the probe, the MoistureMeterD measures only water (dielectric constant = 78.5)

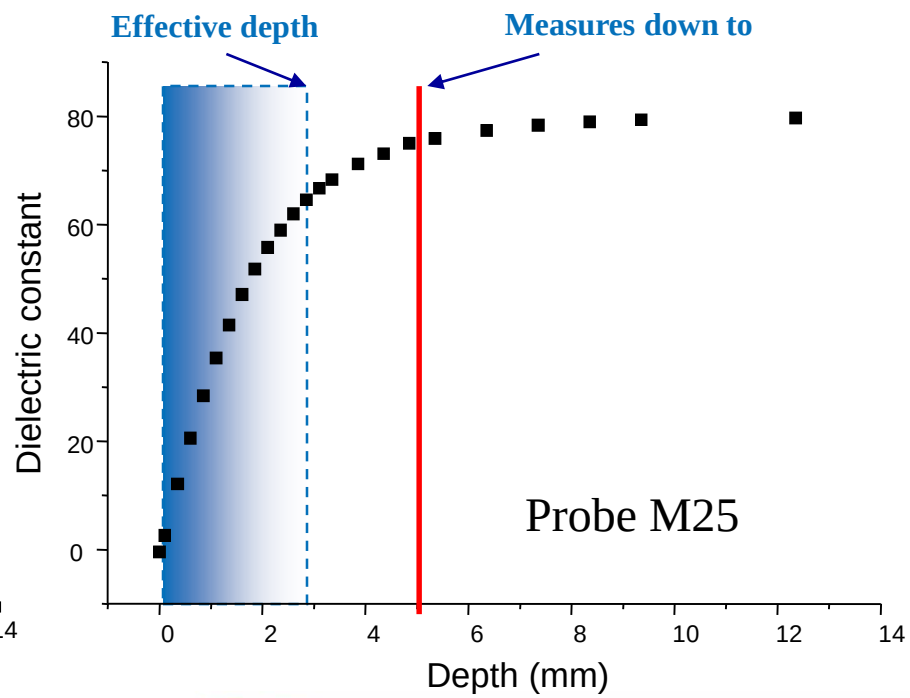


# MoistureMeterD

## Determining the measurement depth

Dielectric constant vs. thickness of the water layer

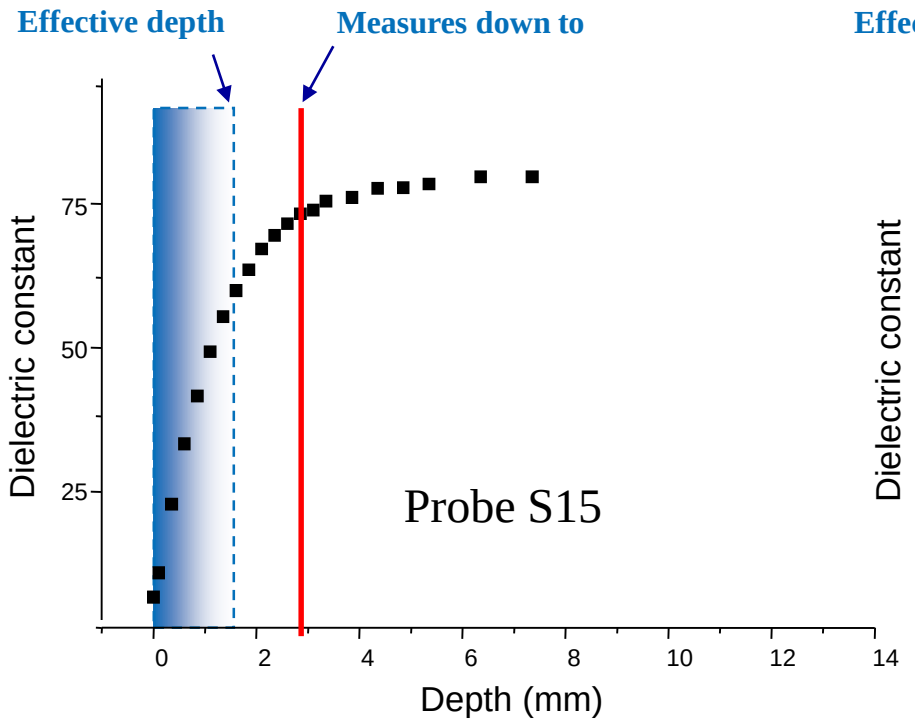


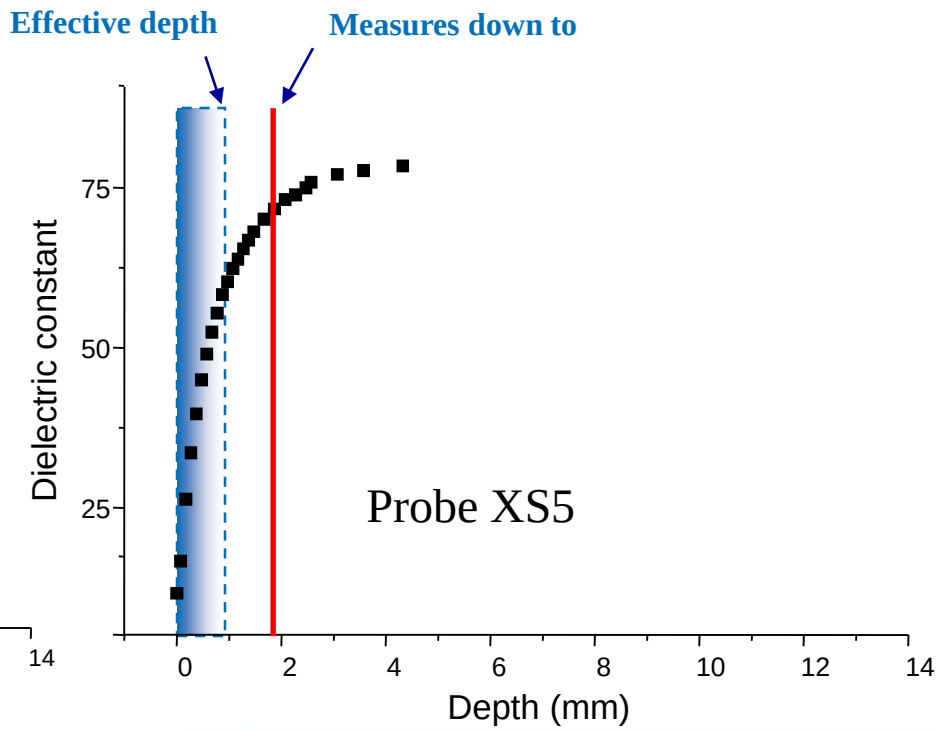




# MoistureMeterD

## Determining the measurement depth

Dielectric constant vs. thickness of the water layer




# MoistureMeterD

## Applications

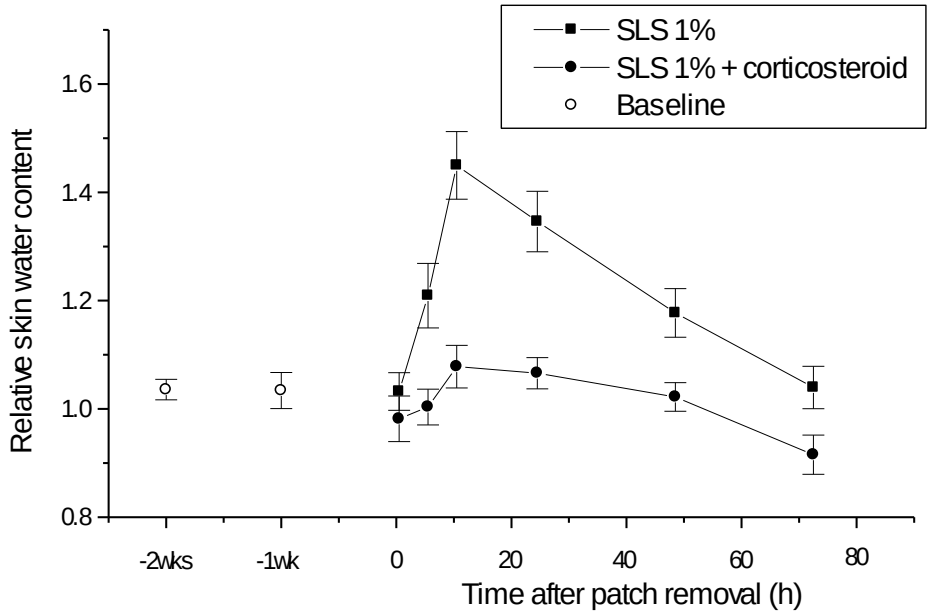
- Secondary lymphedema
  - related to cancer, surgery, drugs, trauma
- Cutaneous edema, tissue fluid status
  - Postoperative fluid status, sepsis follow-up
  - Effect of haemodialysis
  - Ischaemic disorders of extremities
  - Swollen tissue problems
- Cancer medical drug therapy
  - Radiation reactions
  - Drug response in skin
- Burns, thermal injury, wound healing
  - Assessment of burn depth
  - Periwound healing
  - Inflammation-induced edema

- Dermatology, Irritant and allergic skin reactions, drug reactions in skin
- R&D of pharmaceutical products
  - Effect of topical or systemic drugs and ingredients on skin
- R&D of cosmetic and personal care industry
  - Effects of cellulite treatment
  - In-vitro measurement of water containing samples

# MoistureMeterD

## Example

Measurement of irritant- exposed skin by a dielectric technique, probe S15

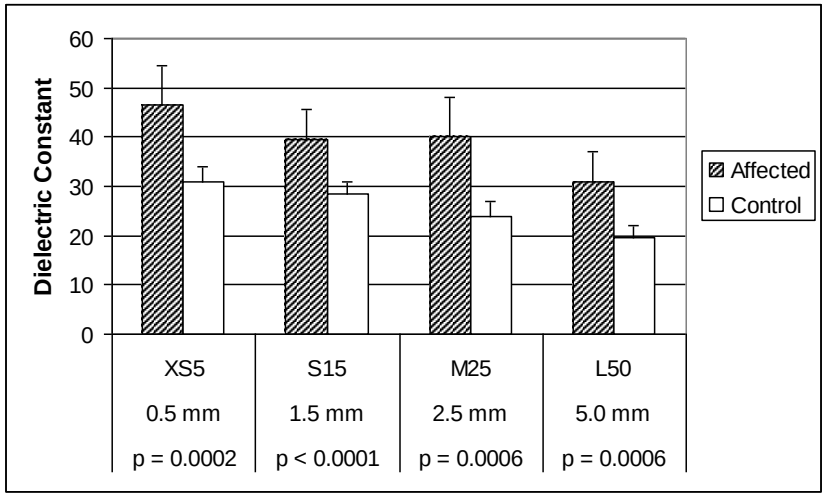



Measurement of oedema in irritant-exposed skin by a dielectric technique
Miettinen M., Mönkkönen J., Lahtinen M.R., Nuutinen J. and Lahtinen T.,
Skin Res Technol, Vol 12: 235-240, 2006.

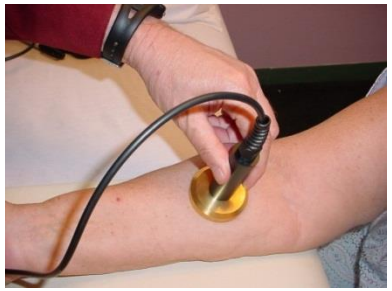
# MoistureMeterD

## Example

Unilateral postmastectomy arm lymphedema




Segment volume technique



Dielectric technique with the MoistureMeterD

Mayrovitz, ICBS 2005:

The dielectric method may serve as

(1) a rapid quantitative assessment procedure for documenting lymphedema, and

(2) early detection of incipient lymphedema that is not yet clinically observable

Data from Dr. H. N. Mayrovitz, College of Medical Sciences, Nova Southeastern University, mayrovit@nova.edu

# MoistureMeterD

## Example

Changes in abdominal subcutaneous fat fluid content with rapid weight loss

9 week's very-low-calorie diet and weight maintenance period 6, 9 and12 months

| | Baseline | 9 weeks | 6 months | 9 months | 12 months |
|---|---|---|---|---|---|
| Weight (kg) | 102.5 ± 12.8 | 86.9 ± 10.4 | 86.2 ± 11.3 | 87.7 ± 10.8 | 88.2 ± 12.4 |
| SAF dielectric constant | 23.3 ± 2.3 | 25.0 ± 2.1 | 24.3 ± 2.4 | 27.5 ± 2.0 | 27.8 ± 1.9 |

SAF=subcutaneous abdominal fat

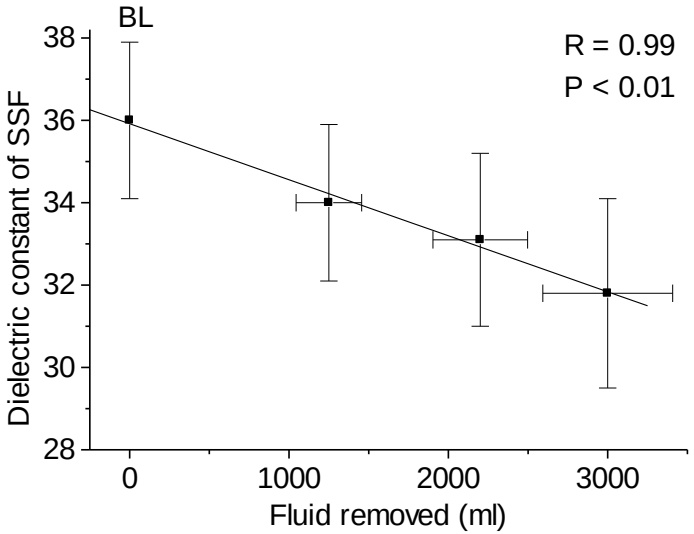
**Conclusion:** Dielectric constant of SAF continued increasing while the weight was maintained. This may describe the better metabolism and increased blood volume in the subcutaneous fat.

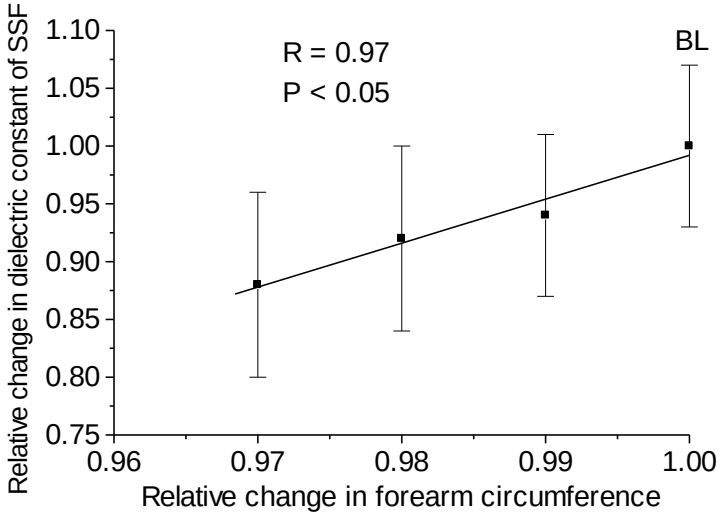
Modified from: Laaksonen D.E., Nuutinen J., Lahtinen T., Rissanen A., and Niskanen LK., Changes in abdominal subcutaneous fat water content with rapid weight loss and long-term weight maintenance in abdominally obese men and women. *Int J Obesity* 27: 677-683, 2003

# MoistureMeterD

## Example

Interstitial fluid removed during haemodialysis treatment, N=7
Dielectric constant was measured with the MoistureMeter D, probe M25



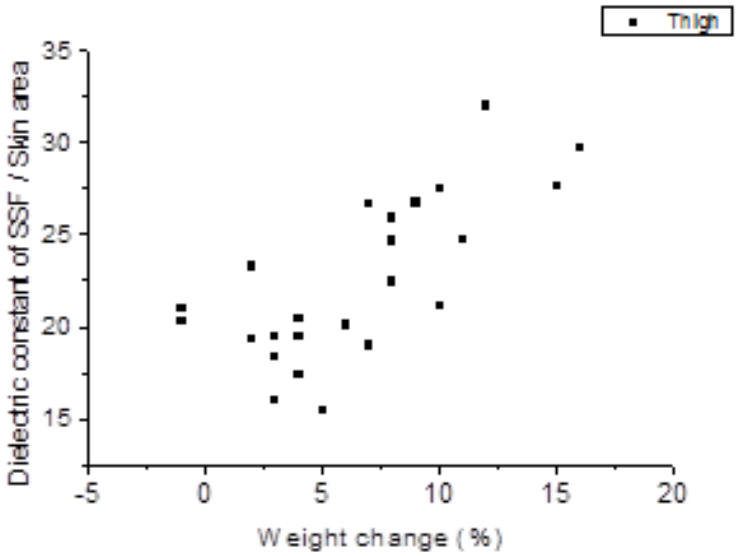

**Conclusion:** Change of dielectric constant correlates well with the fluid removal from the patient. The change in the dielectric measurement was 4-fold compared with the circumferential measurement.

Nuutinen J., Ikäheimo R. and Lahtinen T. Validation of a new dielectric device to assess changes of tissue water in skin and subcutaneous fat *Physiol. Meas.* 25: 447-454, 2004.

# MoistureMeterD

## Example

Dielectric constant of skin and subcutaneous fat to assess fluid changes after cardiac surgery, measurement probe S15




**Conclusion:** The measured tissue dielectric constant indicates edema caused by fluid gain after surgery. The dielectric constant is easier and faster to measure than weigh the bed confined patient.

Petäjä L., Nuutinen J., Uusaro A., et al Dielectric constant of skin and subcutaneous fat to assess fluid changes after cardiac surgery. Physiol. Meas. 24: 383-390, 2003

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Skinlabs
755 NE 164th Terrace
Miami, FL 33162 USA
Tel.+1 (786) 288-0740

info@skinlabsusa.com

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