Objectives

• To be acknowledged on skin elasticity
• To be informed about skin elasticity evaluation techniques
• To differentiate application of each technique

Contents

• Introduction
• Techniques in skin elasticity evaluation
• Application of each technique

Skin

• Skin => tissues + fluids components
• Skin = Viscoelastic body
• Skin => rheology
• Skin = elasticity + viscousity

Elasticity

• Elastin : elasticity
• Collagen : extensibility
• Torsion extensibility sharply reduce @ 35 y

Methods

• Torsion
• Suction
• Wave propagation

Torsion = Twistometer

Skin deformation with torque
• Rotation sensor
• Disc
• Guard ring
• Processor

- 4 - 57 mNm torque
- 1, 3, 5 mm skin crown
- 18 or 25 mm disc
Torsion: Dermal torque meter

Extensibility = \( U_e \)
Elasticity = \( \frac{U_r}{U_e} \)

Torsion: DensiScore

Skin density
Skin creasing

Torsion: Extensometer

- Indentation in skin losing because of tissue viscosity
- Impact pendulum
- Storage = elastic
- Loss = viscous

Torsion: Ballistometer
**Torsion : Ballistometer**

- Kinetic energy from falling object
- Energy transfer => probe rebound releasing
- Greater rebound : elastic/viscosity component is higher
- No. of rebounds
- Amplitude of the first rebound
- Area of the first rebound

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**Suction**

- **Dermalab**
  - 1. Vacuum generator
  - 2. Probe sensor
  - 3. Data processing
    - 10 mm steel ring in probe
    - 0.01 mm accuracy
    - 300 or 450 mbar
    - 4 or 20 s suction
    - 5 or 6 cycle

- **Cutometer**
  - Aperture size
    - 2 mm (epidermis)
    - 4 or 6 mm (outer layers)
    - 8 mm (full thickness)
  - 50 and 500 mbar
  - Suction & relaxation time
    - 0.1 - 60 s
  - 1 - 99 cycle

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**Suction**

- $U_e$ = immediate distension
- $U_f$ = final distension
- $U_v$ = delayed distension
- $U_r$ = immediate retraction
- $U_v/U_e$ increase = elasticity decrease

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Parameters

- Highly elasticity : \( Ur = Uf \)
- \( R0 = Uf \) : passive behavior of skin to force
- \( R1 = Uf - Ua \) : return to original skin state
- \( R2 = Ua/Uf \) : gross elasticity \( \geqslant 1 \)
- \( R3 = \text{last max. amplitude} \)
- \( R4 = \text{last min. amplitude} \)
- \( R5 = Ur/Ue : \text{net elasticity} \geq 1 \)
- \( R6 = Uv/Ue \) : viscoelasticity \( \Rightarrow 0 \)
- \( R7 = Ur/Uf \) : skin firmness \( \Rightarrow 1 \)
- \( R8 = Ua \) : return to original skin state \( \Rightarrow 0 \)

\[ \Delta U_r / U_f = \text{skin firmness} \]

3 cycles, \( T = 22 - 24 ^\circ C, \%RH = 40 - 60\% \) (x3)

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Treatment period</th>
<th>PG gel</th>
<th>Gel base</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volunteer</td>
<td>( D_0 )</td>
<td>0.587 ± 0.020</td>
<td>0.583 ± 0.020</td>
<td>–</td>
</tr>
<tr>
<td>( n = 18 )</td>
<td>( D_{DB} )</td>
<td>0.619 ± 0.018</td>
<td>0.599 ± 0.020</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>( D_{AG} )</td>
<td>0.640 ± 0.018</td>
<td>0.604 ± 0.020</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>( D_{sF-D_0} )</td>
<td>0.032 ± 0.007</td>
<td>0.016 ± 0.012</td>
<td>0.065</td>
</tr>
<tr>
<td></td>
<td>( D_{sE-D_0} )</td>
<td>0.053 ± 0.011</td>
<td>0.021 ± 0.014</td>
<td>0.017</td>
</tr>
</tbody>
</table>


Electrodynamometer

- Skin elastic wave propagation

Reviscometer

- Piezoelectric elements
- Acoustic shockwave emission
- Receiving depend on elastic fibers and moisture content
- Different time wave movement interpreted in to viscoelasticity of skin

References

Objectives

- To be acknowledged on the important of skin image and color
- To be informed on the techniques used for skin image and color analysis

Contents

- Introduction
- Techniques used in skin image
- Techniques used in skin color

Wrinkles

- **Crinkles**
  - A very fine micro-wrinkling
  - Disappear on stretching
  - @ 75 y has crinkled skin
- **Glyphic wrinkles**
  - Primary lines of normal skin surface marking
  - Caused by solar radiation
  - Appear on neck, cheek
- **Linear facial wrinkles**
  - Long, strait, slightly curve
  - Do not disappear on stretching

Facial linear wrinkles

- Horizontal frown lines along the forehead
- Crows feet radiating from the lateral canthus of the eye
- Crease from the nose to the corners of the mouth
- Creases on the upper and lower lips radiated from the mouth
Digital photographed of skin

Index finger of different subject (row)
1st row: bottom segment on palm side
2nd row: finger tip
3rd row: bottom segment on back side

Profilometry

- Skin replica of forehead (56 y M) under relaxation
- Lab conditioned @ 20 - 22°C, 50 - 57% RH

Age-related changes in wrinkle depth

Age-related changes in wrinkle width
Skin image analyzer

- Photography
- Videography
- Magnification
- Different light condition
- Computer program
- Color analysis
  - RGB
  - ITA°: CIELab

Surface topography by videomicroscopy

Microscope image of skin

PRIMOS

Principle
- Direct in vivo 3D method
- Micromirror digital stripe projection system
- Image on a digital matrix camera
- Parameters:
  . Average roughness (Ra)*
  . Maximum difference (Rt)
  . Average relief (Rz)

Skin Image Analyser (SIA)

Principle
- Indirect method via skin replica
- Oblique lighting brings shadows from the replica to the fore
- Analysis of the gray shades

Parameters
- number and average depth:
  . microrelief furrows (<55 µm)*
  . average wrinkles (55-110 µm)
  . deep wrinkles (>110 µm)
- Index:
  . roughness index for the skin surface relief
  . total wrinkled surface

Laser Profilometry

Principle
- Indirect method via skin replica
- Laser diode scanning method
- 3D image reconstitution
- Parameters:
  . Microrelief: complexity, average depth
  . Principal wrinkles: depth, complexity and volume

Visioscan

SIAscope
visioscope
Visioscan

- SEr = roughness
- SEsm = smoothness
- SEw = wrinkles
- SEsc = scaliness

VISIA (RBX)

Skin color

- Melanin (UV)
- Haemoglobin (415, 542, 577 nm)

Skin color

- Colorimetry
  - CIELab
  - Hyperpigmentation decreasing L*
- Chromophore mapping
- Changes in skin color tone
- SIAscopy
- RBX
  - Melanin/haemoglobin deposition across different skin type

Effective (mean ± SEM)

<table>
<thead>
<tr>
<th>Skin parameters</th>
<th>Control</th>
<th>Product</th>
<th>Control</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEr</td>
<td>0.01 ± 0.26</td>
<td>-0.01 ± 0.26</td>
<td>-0.03 ± 0.13</td>
<td>0.17 ± 0.12</td>
</tr>
<tr>
<td>SEsm</td>
<td>-0.03 ± 0.24</td>
<td>-0.59 ± 0.22</td>
<td>0.08 ± 0.15</td>
<td>0.37 ± 0.18</td>
</tr>
<tr>
<td>SEw</td>
<td>1.85 ± 3.14</td>
<td>2.00 ± 3.16</td>
<td>0.74 ± 2.54</td>
<td>0.21 ± 3.36</td>
</tr>
<tr>
<td>SEsc</td>
<td>-1.38 ± 0.89</td>
<td>-1.64 ± 0.89</td>
<td>-4.07 ± 1.64</td>
<td>-4.89 ± 1.80</td>
</tr>
</tbody>
</table>


Skin color

Epidermis: optical filter
Keratinocytes: chromophore (melanin)
Dermal capillaries: chromophore (haemoglobin)
Photography
- Normal light
  - Hypomelanotic or hypermelanotic areas of dermis
- UV light
  - 300 - 400 nm (360 nm)
  - Epidermal change with no dermal color change detection
- Polarized light
  - Based on back-scattered light from tissue
  - Pigmented lesions are easily seen
- Reflectance spectroscopy
  - Tristimulus colorimetry

Reflectance spectroscopy
- Shining white light on the chosen area
- Measure reflected light intensity
- Reflected light at 450, 560, 600 nm
- CIEL*a*b*
  - L = relative brightness
  - b* = pigmentation
  - a* = erythema or redness

Reflectance spectroscopy
- Minolta chromameter (Minolta)
- DermaSpectrophotometer (Cortex)
  - 2 light emitting diodes
  - Green (568 nm)
  - Red (655 nm)
- Erythema Meter (DiaStron)
- Mexameter (CK)
  - 16 light emitting diodes @ 3 wavelengths
  - Green (568 nm) for erythema
  - Red (660 nm) for melanin & erythema
  - IR (880 nm) for melanin

Chromameter
- Clarity (L*)
- Green to red spectrum (a*)
- Blue to yellow spectrum (b*)
- ITA

Protocol design
- Essay areas: forearm
- Treated area and non-treated area
- No photos
- Repeated applications: D0-D56.

DHA = dihydroxyacetone
References


Objectives

- To be acknowledged on skin surface measurement
- To be familiar with skin pH and temperature determination
- To relate each parameter to skin function

Contents

- Skin surface lipid and determination technique
- Measurement techniques of skin pH and temperature

Skin Surface Lipid, pH and temp.
Surface Lipid

Surface lipid component
- Epidermal lipids
- Sebum

Epidermal lipids influence on lipid mixture

Surface lipid

- 10% @ 1 °C increase
- circadian rhythm, high @ noon, low @ evening
- provokes at puberty
- reduces in elderly
- 5 - 6 h refatting of forehead
- 100 h refatting of scalp

Epidermal lipids

- phospholipids
- glycosyl ceramides
- ceramides
- cholesterol
- cholesteryl esters
- fatty acids
- triglycerols
- hydrocarbons

Functions

- cohesion between the skin layers
- regulates the skin permeability
- skin barrier @ 10.3 g/m²h TEWL
- 5 - 10 to 25 - 40 μg/cm²
- Emollient
- No moisturizing effect

Sebum

- Free fatty acid ~ 30%
- Triglycerides ~ 33%
- Wax ~ 15%
- Sterol esters ~ 5%
- Squalene ~ 5%
- Paraffin ~ 7%
- Moisturizer independent

Sebum secretion region

- orange peel skin
- Large pore & greasy skin
- Skin roughness
- Make-up diminishing wearability
- acne
Sebum secretion at different age

Extraction techniques
- Solubility in organic solvents
- Cylinder in known dimension contact to skin
- Chromatographic analysis

Absorption techniques
- Sponge wipe  
  - Few epidermal component
- Cigarette paper
  - Forehead
  - 4 sheets + gauze + rubber band
  - 3 h collection (sebum secretion rate)
  - Ether soke
- Bentonite clay
  - Larger lipids
  - 12 h (sebum secretion rate by glands)

Absorption/Extraction $r = 0.89$

Determination
- Sebutape
  - A lipid-absorbing polymeric film or glass
  - 1 – 5 scale
  - Translucent (or reflectance chromameter: CIE)
- Lipometry
  - 15 s
  - Transmission of sapphire plate (mV)
  - 25 – 500 $\mu$g/cm$^2$
- Sebumeter
  - Plastic film
  - 30 s
  - 0 – 500 scale
- Staining (densitometry)
  - Transparent plate
  - Unsaturated fatty acids reduce osmic acid

Lipometry/Gravimetry $r = 0.94$

Sebutape: CuDerm

Sebutape: DualTape
**Sebutape : Sebufix**

- Transparancy
- 30 - 45 min collection
- CIE
  - \( L = 0 - 100 \) (black - white)
  - \( a = -60 - +60 \) (green - red)
  - \( b = -60 - +60 \) (blue - yellow)
- Adobe pixel scale

**Sebumeter : CK**

- Plastic film cartrige
- 300 measurements (64 mm²)

- 0 - 350 scale
- 350 = 100% transparent
- convert to \( \mu \)g/cm²
- unused film calibration @ \( t = 0 \)
- \( t = 30 \) s

**Correlation**

- Lipometry/Sebumeter
  - \( r = 0.92 \)
- Sebutape/Sebumeter
  - \( r = 0.53 \)
- Sebutape image analyzer/Sebumeter
  - \( r = 0.80 \)

**Sebum Image**

- Normal light
  - Color photo
  - Bright
  - Shadows
  - Pores & blemishes
- Black light
  - Bacteria’s prophyrin
  - \( P. \) acne in sebaceous follicle
- Cross-polarized light
  - Color photo
  - Reflection reduction \( \rightarrow \) skin surface feature
  - Inflammatory lesion

**Fluorescent analysis**

*Wood’s lamp: UVA induces chromophores fluorescence*

**Sebum-image relation parameters**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Red groin serum</th>
<th>White color serum</th>
<th>Tsem serum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red rec. factor</td>
<td>40.800</td>
<td>45.800</td>
<td>46.800</td>
</tr>
<tr>
<td>Red rec. (E%)</td>
<td>1.07</td>
<td>0.17</td>
<td>0.37</td>
</tr>
<tr>
<td>Green rec. (E%)</td>
<td>0.05</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Nonspecific activity</td>
<td>2.35</td>
<td>0.94</td>
<td>2.16</td>
</tr>
<tr>
<td>Activity index (%)</td>
<td>100</td>
<td>13</td>
<td>11%</td>
</tr>
<tr>
<td>Activity (E%)</td>
<td>2.25 x 10²</td>
<td>2.25 x 10²</td>
<td>2.25 x 10²</td>
</tr>
</tbody>
</table>

- Red, green, blue : color parameters
Skin pH

- Sweat = hypotonic solution; pH 4.5 - 5.5
- Acidic skin provides defense against microbe
- Higher pH, more microbial growth
- pH range 4.0 - 6.5
- Means pH = 5.5 (1987)
- Infant skin pH = 6.6
- Variation in region, sex, race, age
- Male lower than Female
- Axillary pH is higher than means pH

• Natural skin surface pH = 4.7
• Cosmetics pH labels skin pH range of 5.4 and 5.9
• pH 8 formulation: increase TEWL
• pH 3 - 4 formulation: shedding of corneocytes from outer layer

Skin pH

Cosmetics actions on
- Solubility
- Partitioning
- Absorption
- Penetration

Towards skin
- *in vivo*
- *in vitro*

**Cosmetics efficacy** particularly antiperspirant & deodorant

pH & temperature

• Flat glass electrode
• Fluorescent
• Infrared
• Laser Doppler

Skin pH

<table>
<thead>
<tr>
<th>pH</th>
<th>Acid</th>
<th>Normal</th>
<th>High pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td></td>
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</table>

References