**In vivo OCT investigation of chemical enhance of the rat skin optical clearing by fructose solutions**

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**BACKGROUND**

Optical technologies of treatment and diagnostics are widely used and developed in medicine. But high tissues scattering limits light penetration into tissues. It is possible to decrease tissue scattering by optical clearing of tissue by hyperosmotic chemical agents. This reversible process is based on partial replacement of tissue interstitial fluid by the biocompatible chemical agent and thus temporal dehydration of tissue, which leads to refractive index matching between the tissue components and change of tissue packing.

In this study comparison of effect of application two agents is demonstrated: aqueous 50%-fructose solution and aqueous-alcohol 50%-fructose solution, to demonstrate the application of chemical enhancement of optical clearing.

**MATERIALS AND METHODS**

**Object of investigation**

*In vivo* skin of white Wistar rats

**Optical clearing agents (OCAs) and RI (930 nm)**

- Aqueous 50%-fructose solution (1.3920)
- Aqueous-alcohol 50%-fructose solution (1.4042)

**OCT measurement**

The Spectral Radar OCT System OCP930SR 022 (Thorlabs Inc., USA) with a wavelength of 930 nm was used to quantify the change in the optical properties of the skin. After hair removal from the mouse skin, a B-scan of the intact skin region with OCT was recorded. Then the solution was applied topically to the target skin area. Skin OCT scans were recorded every 5-10 min during the exposure of the skin area to the solution. The solution was removed each time before scanning and applied again after scanning.

**Data Processing**

OCT scans were used to calculate the kinetics of light attenuation coefficient in the skin by approximating the dependence of the intensity of the reflected light (I(t)) on the depth of the investigated region z of A-scan recorded at the time t by the equation:

\[ I(z,t) = I_0 \exp(-\mu(z,t) \cdot z) \]

The light penetration depth of the skin was determined from the coordinates, upon transition between which the signal intensity decreases by a factor of e (Δx = z1 - z2) before and optical clearing.

For estimation of characteristic time of skin optical clearing, the obtained time dependence of light attenuation coefficient in the skin was approximated by the equation:

\[ \mu_{\text{skin}}(t) = \frac{\mu_i - \mu_f}{\tau} + \mu_f \]

where \( \mu(t) = 0 \) and \( \mu(t) \) are the values of the light attenuation coefficient at the time \( t = 0 \) and \( t \), respectively; \( A \) is the maximum degree of optical clearing of the sample; \( r \) is the characteristic time of optical clearing of the sample; \( \gamma \) is the residual value of that can be achieved.

**RESULTS**

**Time-dependences of light attenuation coefficient**

*in the skin*

- Aqueous 50%-fructose solution
- Aqueous-alcohol 50%-fructose solution

**Time-dependences of light penetration depth**

*into the skin*

Values of fructose diffusion coefficient in rat skin *in vivo*, skin permeability for fructose, characteristic time \( \tau \) and efficiency \( \text{OC}_{eff} \) of optical clearing of rat skin *in vivo*

<table>
<thead>
<tr>
<th>Optical clearing agent</th>
<th>Diffusion coefficient, cm²/sec</th>
<th>Permeability coefficient, cm/sec</th>
<th>( \tau ), min</th>
<th>\text{OC}_{eff}, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aqueous 50%-fructose solution</td>
<td>(1.72±1.28)×10⁻⁶</td>
<td>(2.29±1.71)×10⁻⁴</td>
<td>9.3±6.3</td>
<td>53±15</td>
</tr>
<tr>
<td>Aqueous-alcohol 50%-fructose solution</td>
<td>(3.25±2.00)×10⁻⁶</td>
<td>(4.34±3.74)×10⁻⁴</td>
<td>4.4±3.1</td>
<td>53±14</td>
</tr>
</tbody>
</table>

**CONCLUSION**

Thus, as a result of the conducted studies it was established that ethanol addition to aqueous fructose solution accelerates optical clearing of rat skin *in vivo*. The aqueous-alcohol 50%-solution of fructose showed more fast optical clearing but the same optical clearing effect of rat skin compare to fructose solution without alcohol.

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