Skin optical density changes after low power Laser irradiation

Inesa Fenzlova1, Janis Lesins1, Dainis Jakovels1, Alexey Lihachev1 and Janis Spigulis1

1 Biophotonics Laboratory, Institute of Atomic Physics and Spectroscopy, University of Latvia, Riga, Latvia
lnesa.fenzlova@gmail.com

The aim of present study was to investigate low laser irradiance influence on healthy skin using diffuse reflectance spectroscopy (DRS) and multispectral imaging [1]. Changes in skin diffuse reflectance in spectral range 500nm - 600 nm were observed after laser provocation. Changes depend on irradiation wavelength and power density. Skin was irradiated by cw low-power lasers with wavelengths of 405nm, 473nm and 532nm.

Two methods of skin diffuse reflectance spectra recording were used in the study: the single-spot irradiation/detection by means of fiber optic probe and spectrometer, and the non-contact method by means of multi-spectral imaging system. Diffuse reflectance spectra were registered before and after laser irradiation of 60 second period.

Contact method

- Halogen lamp AvaLight-HAL 10 W
- Spectrometer AvaSpec-2048-2
- Cw low power lasers
- Lasers wavelengths: 532nm, 473nm, 405nm
- Lasers power density: 20mW/cm² - 120mW/cm²
- Fiber optic contact probe

Non-contact method

- Multi-spectral imaging system:
  - Nuance 2.4
  - 100W tungsten incandescent lamp
  - Cw low power lasers
  - Lasers wavelengths: 473nm, 405nm
  - Lasers power density: 100mW/cm² - 120mW/cm²

The polarizer was oriented orthogonally to the built-in polarizer of the camera, so significantly reducing the influence of skin specular reflection.

Changes of relative optical density depending on irradiation power density. a) skin was irradiated with cw laser of 532 nm, b) skin was irradiated with cw laser of 473 nm, c) skin was irradiated with cw laser of 405 nm

Temporal behavior of optical density changes demonstrated a fast return to the reference level in about 3 minutes after 532 nm laser irradiation. The same tendency was observed if 405 nm and 473 nm lasers were used, but the return time was slightly longer. Our previous study [1] showed that autofluorescence recovery kinetics after laser irradiation is a long term effect. Peaks at 542 nm and 577 nm in the relative optical density correspond to absorption of hemoglobin [2]. The obtained results show that laser irradiation can affect the layers of human skin. Probably, complicate mechanisms of low power laser irradiation may cause direct skin fluorophore (for instance, porphyrin) degradation, as well as modification of absorption and quenching properties by both photo- and thermally-induced biophysical and biochemical processes inside the highly heterogeneous tissue structure. Appearance of hemoglobin absorption in the skin is caused by local fluorophore degradation during optical excitation, thereby increases the probability of light to penetrate to the deeper skin layers, where skin capillaries and vessels are located. Also it is assumed that laser irradiation causes inflammation by local heating and to this place comes more blood in regard to expanded capillaries, as an innate immune system defense of the organism to injurious stimulus.

Skin diffuse reflectance spectra showed increased hemoglobin level after 405nm, 473nm and 532nm cw laser irradiation at power densities around 100 mW/cm² (twice below the laser skin safety limit [3]). This indicates to some photo-inflammation; mechanism of erythema creation may be similar to that of sun-caused erythema. Accordingly to the obtained results, visible laser skin safety limits should be lowered at least for an order of magnitude to avoid any photo-biological effects.

References: