Comparative Attenuation Spectra of Liquid Skin-Like Phantoms

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Abstract: This study aims to extract and compare attenuation coefficients of different liquid skin-like phantoms representing Skin Types I to VI with two methods, Spectrophotometric and Integrating Sphere methods. The correlation between the results of the 2 methods was excellent.

1. Introduction

Spectrophotometric (SP) and Integrating Sphere (IS) methods are commonly used to extract optical characterisation information from skin tissue, although the latter method is used more widely [1,2]. The aim of this study was to extract the attenuation coefficient (μ_t), which is the fraction of photons removed from the sample due to the scattering and absorption processes occurring in the sample, using both methods. Two different skin-like phantom sets investigated: (a) Different concentrations of synthetic eumelanin and added Intralipid (IL) (20% fat emulsion) and (b) the same eumelanin concentrations but with added bilipid membrane artificial vesicles (Pheroid^{TM}). Transmittance spectra of the samples were measured with a UV-VIS spectrophotometer (Shimazdu UV-1650 PC) using standard 1 cm pathlength. Attenuation coefficients ($\mu_t(\lambda)$) were calculated from

$$\mu_t(\lambda) = \frac{-\ln T(\lambda)}{L} \qquad [1/cm] \tag{1}$$

with $T(\lambda)$ the wavelength dependent transmittance and L the pathlength (in cm). Reflectance and transmission measurements were also taken for each sample using an 8 inch diameter Integrating Sphere (Labsphere) connected to a white light source. The signal was detected by a fibre (600 µm core diam) coupled spectrometer (Ocean Optics USB4000). In addition to μ_t absorption and reduced scattering coefficients (μ_a and μ_s') can be extracted from a calibration model consisting of a matrix of elements of known μ_a and μ_s', created using different concentrations of Intralipid (20%) (scatterer, non-absorbing) and black dye (absorber, non-scattering) solutions, using the Newton-Raphson method [3].

2. Results

The μ_t obtained using the 2 methods are within similar ranges of each other (-0.2 – 1.8cm^{-1} for SP data) and (0.5– 2cm^{-1} for IS data). Although the absolute values of the two may not be the same the trends exhibited by both sets of data are consistent with the exception of the samples that contain 30µl Intralipid. The 30µl intralipid samples contain the highest scattering population and one would expect μ_t to be much higher for these samples as shown by Fig. 2. The low μ_t seen in Fig.1 may be a consequence of the higher scattering present in the samples dominating over the absorbance hence resulting in a lower absorbance signal for the SP measurements. While the current results indicate good agreement, these samples will be further investigated on a double IS system which is considered better for the extraction of μ_a and μ_s'. The optical properties obtained by the different systems will then be compared to understand the dynamics of the different samples which will enhance the understanding of the different skin types.

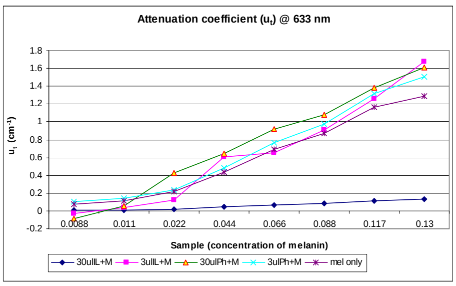

Fig 1: μ_t extracted from spectrophotometer data

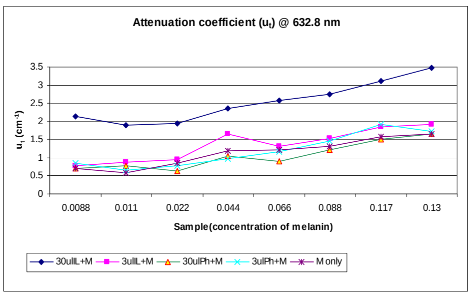

Fig 2: μ_t extracted from IS data

3. References

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