

FULL-FIELD OPTICAL COHERENCE TOMOGRAPHY FOR RAPID SKIN CHARACTERISATION

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Introduction

In this work we present a measurement technique for profiling of the superficial skin layers based on an open space Optical Coherence Tomography (OCT) microscope utilising Smart Pixels technology [Bourquin, 2000]. A fully automatic processing scheme has been developed that is shown to provide near instantaneous estimates of the clinically-relevant skin dimensions such as epidermal thickness (ET), thickness of the dermal-epidermal junction (DEJ) and the end of papillary junction or the depth of dermis (DD). The skin characterisation procedure is performed without contact to the imaged area and requires only a few minutes to complete including the time taken for placement of the patient arm under the microscope measurement head.

The OCT measurements were performed on the dorsal part of the upper arm and validated with reference measurements provided by a commercial Laser Scanning Confocal Microscope (LSCM) VivaScope 1500 from Lucid Inc. (USA) followed by expert-assisted image analysis.

Measurements were performed on 22 patients (13 males and 9 females) with Type 1 Diabetes Mellitus (age; 41.7 ± 12.7 years; body mass index: 24.2 ± 2.8 kg/m²; duration of diabetes 19.8 ± 12.8 years; HbA1c: $6.9 \pm 0.7\%$) enrolled in the clinical studies performed at the Centre for Clinical Research, University Hospital Zurich, Switzerland..

Results

We have extracted different estimates of ET as measured by other groups [Neerken, 2004], such as the distance from the surface entrance signal (first maximum) to first minimum (OCT_min), to the second maximum (OCT_max) and to the half level between minimum and maximum (OCT_level). The highest correlation with LSCM ET corresponds to the distance from the OCT_min ($r \approx 0.82$, $p < 0.0001$) as can be seen in Fig. 1. The OCT_max has slightly lower correlation with LSCM ET ($r \approx 0.65$, $p \approx 0.0009$) and is probably related to the DD. We observed a decrease in the DD with age due to the thinning of the DEJ, which agrees with findings of other groups.

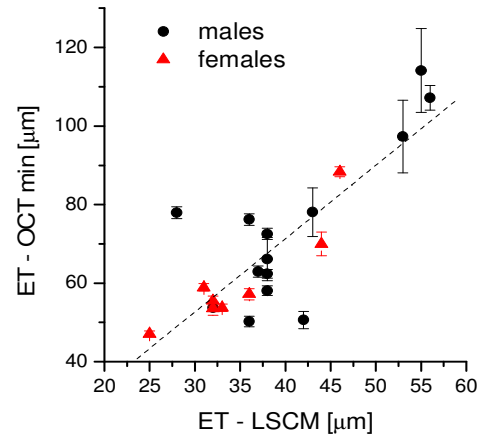


Figure 1: Cross-plot of OCT_min and LSCM based estimation of ET

The DD also has a statistically significant correlation with body mass index (BMI). Lower mean values of ET and DD for females (see right graph in Figure 1) can be related to the smaller BMI when compared to males.

We have also revealed a high negative correlation of the dermal reflectivity with age ($r \approx -0.75$, $p < 0.0001$), which can most likely be associated with photoaging. As a part of intrinsic aging processes [Rigel, 2004] there is collagen degradation in the dermal layer due to the exposure to UV light.

In conclusion, the procedure involving fast data acquisition of the skin layers with a parallel OCT microscope followed by automatic quantification of the skin morphology has been developed and validated with a human-assisted LSCM investigation. Correlations with patients' demographic characteristics have been observed.

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References

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