

CHARACTERIZATION OF PHOTO DAMAGED SKIN USING 3D LINE-FIELD OPTICAL COHERENCE TOMOGRAPHY AND HISTOPATHOLOGICAL CORRELATION

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INTRODUCTION & OBJECTIVE

Chronic sun exposure is responsible for skin photoaging. Noninvasive imaging techniques are able to morphologically characterize photoaging and generate qualitative analysis in photodamaged skin. Optical coherence tomography (OCT) is one of the non-invasive available technologies that allows a deep laser penetration in the surface, reaching a good quality image of dermis visualization. It creates *in vivo* cross-sectional (vertical) and *en face* (horizontal) images of the skin with an isotropic resolution of 1.3 µm and a penetration depth of 500 µm. A new three-dimensional technology, 3D line-field confocal OCT (LC-OCT) (DAMAE Medical, Paris) has been introduced, allowing a vertical and horizontal reconstruction of the complete skin with cellular resolution.

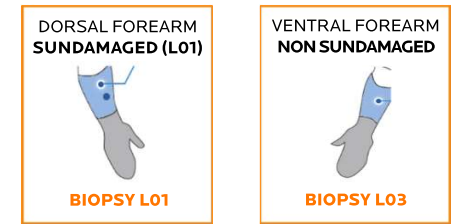
Our objectives were to observe in an *in vivo* three-dimensional mode, the morphological and cytological changes of photodamaged skin, in order to better understand the changes of the different layers of the skin, induced by chronic sun exposure and responsible for chronic sun-damages.

MATERIALS & METHODS

In this study, we conducted a descriptive and observational investigation, after the approval of the Ethics Committee at Hospital Clínic de Barcelona, in order to determine the 3D LC-OCT characteristics of sun damaged skin.

Between June and July of 2020, nine phototype II-III patients in their fourth to sixth decade of life were prospectively included. Dermoscopy and LC-OCT was performed on two different zones: the sun-damaged area on dorsal forearm (L01) and the non-sun-damaged area on ventral side of the same forearm (L03). Skin biopsies were obtained of both observed areas.

Quantification of the structural morphology of the skin's upper layers was obtained: The thickening of the Stratum Corneum (SC), of the stratum spinosum, and the flattening of the Dermal Epidermal Junction (DEJ) were evaluated. The number and density of keratinocyte nuclei were also quantified.

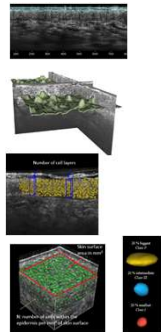


RESULTS

All metrics were compared as paired data on 9 patients. No statistically significant differences were observed for the LC-OCT SC thickness and the DEJ undulation. By image analysis of LC-OCT, we showed that the epidermis thickness was increased (mean: 5.39 µm, p= 0.0078) and that the number of keratinocytes was higher (mean=0.997; p= 0.002) in exposed area (L01) in comparison with non-exposed one (L03). Under LC OCT analysis, the volume of the different layers of keratinocytes seemed to be larger for the more sun-exposed area (mean 0-20%: 4.61 µm³, mean 40-60%: 26.22 µm³, mean 80-100%: 55.34 µm³). Concerning the histology analysis, comparison between both areas as paired data, we showed an increased thickness of the epidermis (mean: 11.07µm, p=0.011) on exposed areas. Significant differences were also observed for the number of keratinocytes layers that was higher for the chronic photodamaged skin (mean: 0.77, p=0.029). Those results are well correlated with LC-OCT one's.

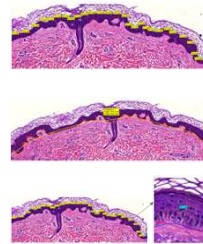
LC-OCT METRICS

- Stratum Corneum (SC): semi-automatic segmentation of the skin surface and the end of SC
- Epidermis Thickness: semi-automatic segmentation of the skin surface and the DEJ.
- Epidermis without SC: difference between entire epidermis and SC thicknesses
- DEJ undulation: DEJ area divided by the flat area of the region of interest (%)
- Keratinocytes quantification: number of cells within the epidermis per mm² of skin surface, average number of cell layers within the epidermis, keratinocyte nuclei volume and compactness.

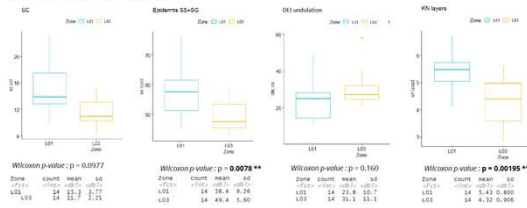


HISTOLOGICAL METRICS

- Epidermis without SC (Stratum Spinosum): Average of 30 control lines evenly distributed within the epidermis and perpendicular to the surface/DEJ.
- DEJ undulation: Ratio of DEJ length over region of interest length(%).
- Keratinocytes quantification: Average of the number of cell layers over 30 control lines evenly distributed within the epidermis and perpendicular to the surface/DEJ.

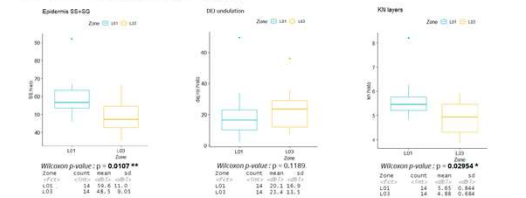


L01 vs L03 LC-OCT BOX PLOT



Conclusion : Under LC-OCT measurement the epidermis is significantly thicker on the exposed lesion and the number of keratinocytes layers is higher. No statistically significant differences were observed on DEJ undulation and SC thickness.

L01 vs L03 - histological analysis BOX PLOT



Conclusion : Under histological measurement, the epidermis is significantly thicker on the exposed lesion and the number of KN layers is higher on the same exposed lesion. No statistically significant differences were observed on DEJ undulation.

CONCLUSIONS

We present for the first time a study of photodamaged skin in 3D, with quantitative and objective measures comparing normal and chronic photodamaged skin. We demonstrated that the epidermis was significantly thicker on the exposed area and that the number of keratinocytes layers was higher in the same area with good correlation which were consistent with the histopathological findings.

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