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NON-INVASIVE MONITORING OF PDT ON SKIN SQUAMOUS CELL CARCINOMA USING THE OPTICAL ATTENUATION COEFFICIENT MEASURED BY OCT

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Introduction: Skin squamous cell carcinoma (SCC) is a non-melanoma skin cancer associated with a substantial risk of metastasis. An alternative treatment with excellent cosmetic results is photodynamic therapy (PDT). Non-invasive monitoring of tumor evolution during PDT can be performed by Optical Coherence tomography (OCT), performed non-invasively in real time. Optical attenuation coefficient (OAC) can be extracted from the raw backscattering OCT images. In this study we aim to use the OAC to optically characterize the tissue and evolution of SCC during PDT and as a marker of PDT efficiency.

Material and Methods: After 28 weeks of in vivo chemically-induced skin SCC on 50 Swiss female mice [1], animals were divided in: G1-Healthy skin, G2-Neoplastic Skin, G3-Neoplastic skin + ALA 20% + PDT, G4-Neoplastic tissue + MEALA 10% + PDT. Light irradiation was performed with a 630 nm LED cluster (180 mW, 5 mW/cm^2), 40 minutes, 12 J/cm^2. OCT was performed at 10 and 20 days after PDT, (OCP930SR, Thorlabs, USA). Optical axial resolution was 1.38 μm and lateral resolution 6.1 μm. The Optical Attenuation Coefficient (OAC) was calculated through a program developed in our laboratory considering a simple exponential decay where total OAC is integrated over a specific depth.

Results: There is significant difference between the groups (ANOVA,Turkey-Kramer, 5%). OAC of neoplastic tissue is higher than OAC of healthy skin by a factor around 1.4. OAC of neoplastic tissue in G3 and G4 subjected to PDT tend to approach that of healthy tissue, showing a positive response to treatment.

Discussion: The cellular and morphological changes were assessed using visual macroscopic inspection, histopathology, and OCT imaging. OAC of neoplastic tissue is higher than healthy skin due to higher number of epithelial cells present in tumor hyperplasia, increasing the attenuation of light. Moreover, tissue disorganization in tumor increases the number of interfaces and thus light scattering. We noted a reduction of OAC 10 days after PDT, showing the efficiency of the treatment. After 20 days, group G3 showed an increase in OAC that could mean that another session of PDT would be needed to complete the treatment.

Conclusion: Neoplastic lesions present a higher optical attenuation coefficient than healthy skin, and followed the evolution of the OAC during PDT. Although analysis of OAC is novel and requires a precise delimitation of the region of interest, we believe this optical property can provide relevant information on the state of the tissue. Moreover its non-invasiveness makes it a promising tool for the diagnosis of skin lesions and monitoring of therapy.

References:

[1] Abel, E. L., Angel, J. M., Kiguchi, K. & DiGiovanni, J. "Multi-stage chemical carcinogenesis in mouse skin: Fundamentals and applications." Nat. Protoc. 4, 1350–1362 (2009).