Advances in clinical multiphoton microscopy of melanoma and other skin conditions

Mihaela Balu1, Griffin Lentsch1, Joshua Williams1, Ronald M. Harris2, Karsten Koenig3,4, Christopher B. Zachary2, Kristen M. Kelly2, Bruce J. Tromberg1
1 Beckman Laser Institute, University of California, Irvine, Irvine, CA, 92612
2 Department of Dermatology, University of California, Irvine, CA, 92697
3 JenLab GmbH, Schillerstrasse 1, Jena, Germany
4 Department of Biophotonics and Laser Technology, Saarland University, Saarbrücken, Germany
E-mail: mihaela.b@uci.edu

KEY WORDS: multiphoton microscopy, clinical skin imaging, melanoma imaging

Multiphoton microscopy (MPM) can provide sub-micron resolution images of living tissues in their native environment with contrast from multiple modalities, including second harmonic generation (SHG) and two-photon excited fluorescence (TPEF). Over the past several years we have employed a powerful commercial multiphoton microscope (MPTflex, Jenlab, Germany) to advance the label-free MPM technology in skin imaging clinical studies for characterizing keratinocyte metabolism, diagnosing melanoma, detecting basal cell carcinoma, assessing the effects of cutaneous laser therapy, etc. In MPM imaging of skin, the main sources of fluorescence are NADH, FAD, keratin, melanin, and elastin fibers, whereas SHG is used to visualize collagen fibers in the dermis.

This presentation will include a summary of current advances in our clinical skin research studies using in vivo MPM with a focus on pigmented lesions imaging for non-invasive diagnosis of melanoma. Data acquired from pigmented lesions in 50 patients were analyzed both qualitatively by comparison of the MPM and histology morphological features and quantitatively by defining metrics based on TPEF, SHG, and density of melanocytic dendrites in the upper epidermal layers. Figure 1 shows representative examples of MPM images acquired from a melanoma lesion in a patient.

The results of this study provide a set of morphological MPM features typical to common, dysplastic nevi, and melanoma, along with an algorithm based on quantitative measurements, which shows great potential to discriminate these groups of melanocytic lesions.

Current limitations of the MPM technology and potential approaches to overcome them will also be addressed.