UTILIZING DIGITAL HOLOGRAPHIC MICROSCOPY TO QUANTIFY NANOCAPSULE INDUCED ALTERATIONS OF MORPHOLOGY AND MIGRATION IN EPITHELIAL SINGLE CELL LAYERS

M. Kaiser[1], L. Pohl[2], S. Ketelhut[2], L. Kastl[2], C. Gorzelanny[3], M. Götte[4], J. Schnekenburger[2], F. M. Goycoolea[5], B. Kemper[2]*

[1]Max Delbrück Center for Molecular Medicine, Robert-Rössle-Strasse 10, D-13125 Berlin, Germany

[2]Biomedical Technology Center, University of Muenster, Mendelstr 17, D-48149 Muenster, Germany

[3]Department of Dermatology and Venerology, University Medical Center Hamburg-Eppendorf, D-20246 Hamburg, Germany

[4]Department of Gynaecology and Obstetrics, Muenster University Hospital, Albert-Schweitzer-Campus 1, Building, A1, D-48149 Muenster, Germany

[5]School of Food Science and Nutrition, University of Leeds, Leeds LS2 9JT, UK

***E-mail: bkemper@uni-muenster.de[2]**

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ABSTRACT

We applied quantitative phase imaging (QPI) with digital holographic microscopy (DHM) [1] for quantification of nanocapsule-induced morphology and migration changes in single cell layers. Capsaicin filled chitosan capsules were used as drug delivery model as both substances show a wide range of biological activities. We investigated the nanosystem's influence on migration and morphology of Madin Darby canine kidney (MDCK-C7) epithelial cells in comparison to the capsaicin-free nanoformulation, free capsaicin, and control cells. In repeated time-lapse observations, cells were monitored with a Mach-Zehnder interferometer-based off-axis DHM setup up to 18 hours. For minimally invasive quantification of cell migration, single cells were tracked in the recorded series of quantitative DHM phase images. In addition, quantitative DHM phase images were used as novel stain-free assay to quantify the temporal course of global cellular morphology changes during the observation period. The obtained QPI results were compared to complementary data from investigations on cytoskeleton alterations and tight junction protein redistributions with immune fluorescence microscopy and calcium influx measurements. The retrieved label-free QPI data show that capsaicin-loaded and unloaded chitosan nanocapsules, and also free capsaicin, significantly influence the direction of cell migration and cellular motility [1]. Moreover, the observed increase of velocity and directionality of cell migration correlates with the label-free detected global morphology changes of the cell layers, tight junction integrity and cytoskeleton alterations. In conclusion, our results demonstrate for the example of DHM the capabilities of QPI for multi-modal quantification of the impact of nanosystems and drugs.

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