Optical knocking out of single cells in tumor spheroids and stem cell clusters using nanojoule femtosecond laser pulses

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ABSTRACT

Single cells within living tumor spheroids and 3D stem cell clusters were knocked out by tightly focused femtosecond laser pulses. The precise optical knocking out of a particular single cell was performed by single point illumination and was confirmed by taking three-dimensional multiphoton images based on autofluorescence and fluorescent probes. In particular, cell viability, the production of reactive oxygen species, and the possible formation of DNA strand breaks have been studied on the target cell as well on the surrounding cells after femtosecond laser irradiation in dependence on exposure parameters such as laser power and exposure time. The results confirm that long-term scanning of cells can be performed without impact on cellular metabolism and vitality and that selectively inactivation of a single cell was possible without altering neighbouring cells or compromising cell viability. Therefore, multiphoton microscopes can be considered as biosafe tools for long-term diagnostic studies as well as highly-localized nanoprocessing of living specimens within specific optical windows determined by wavelength, intensity and exposure time.

Keywords: NIR, femtosecond laser, ROS, TUNEL, nanoprocessing, stem cells, optical knocking out