Popular science abstract

Hyperthermia (HT) as an anticancer treatment has a long history. Medical practitioners in ancient India used supra-normal body temperatures to treat breast cancer. In modern oncology hyperthermia is defined as a controlled tumor heating. Research studies have shown that the temperatures above physiological conditions can selectively damage heat sensitive cancer cells, usually with minimal injury to normal tissues. Despite many advantages, the conventional whole- body and regional hyperthermia has clinically relevant side effects for patients undergoing chemo- or radiotherapy at the same time. In addition, during hyperthermia treatment inhomogenous heat distribution is taking place what can result in insufficient killing of tumour tissues. The lack of accessibility of deep-seated tumor sites and impaired targeting micrometastases renders hyperthermia also less effective.

It is believed that these disadvantages can be significantly overcome by application of biofunctionalized nano- and microparticles, which can specifically target tumor sites and become activated by external stimulus to provide a sufficient cellular response. However application of nanoparticles for hyperthermia treatment raises further questions, e.g. how to control the temperature during treatment to avoid the unnecessary exposure of healthy tissue to harmful factors, why tumor cells are more susceptible to HT compared to healthy cells and whether different cancer types respond equally to hyperthermia? Many of the above mentioned issues will be addressed by the authors of the proposal. For this purpose, the micron-size materials named microrobots (μR) will be designed, developed and optimized. Microrobots will be contactless controlled and photoactivated by multi-parameter optical trapping system at few wavelengths and will be applied in the project as light-to-heat converters, sensitive thermometers and micron-sized pH sensors. The unique optical tweezers system will enable capturing the microrobots, primary cells and multicellular spheroids in highly controllable and reproducible environment in order to study the impact of localized heat stimulation on normal and pathological cell and within multicellular spheroid coculture. The cancer model will include the colorectal cancer and Non-Hodgkin lymphoma.

For decades, scientists have been trying to understand the biological mechanisms underlying the positive effects of hyperthermia treatment at the single cell level. We expect that designed optical trapping system together with unique micro- and nanomaterials and tree- dimensional biological models will enable to understand of pathophysiology of cancer cells in more details. The developed methodology will be also suitable to study the complex mechanisms of cancer drug resistance in the future.