

Emerging method: modulated electro-hyperthermia – biophysical principles

Oliver Szasz¹, Gabor Andocs², Andras Szasz³

¹*Department of Biotechnics, Faculty of Engineering, St. Istvan University, Budapest, Hungary,*
²*Department of Pharmacology and Toxicology, Faculty of Veterinary Science, St. Istvan University, Budapest, Hungary,* ³*Department of Biotechnics, Faculty of Engineering, St. Istvan University, Budapest, Hungary*

Objective: Hyperthermia (HT) was applied much before than any of other therapies in oncology. However it is not accepted yet, due to its controversial results. The problem was the missing technique of the selective deep heating, which were causing various side- and contra effects. Our aim is to show a new technique, modulated electro-hyperthermia (mEHT), which could solve many of the old problems with modern technical facilities.

Material and Methods: Modulated electro-hyperthermia (mEHT) is impedance coupled heating, using the constrained conductive way of 13.56 MHz modulated radiofrequency (RF). Time-fractal modulated RF-current flows through the patient's body between the two electrodes of an appropriate condenser. Patient is active part of the controlled electric circuit. Due to the higher glucose metabolic of most of the malignant cells the ion-concentration (so the frequency dependent conductance) is definitely larger in the extracellular matrix of the tumor than in its healthy counterpart. This makes possible a selective deep heating.

Results: The well applied modulated electric field could produce high difference by the heating of the extra- and intracellular electrolyte, so a heat-flow is constrained through the cell-membrane. Conductance differences automatically control the focusing on cellular level and acts selectively. The mainly extracellular current has thermal- and electric-gradients, (non-equilibrium condition), which governs numerous effects, like lowering the membrane potential (5%), increasing the membrane permeability (80%), increasing the intracellular pressure (30%), unbalancing the ion-exchange, reestablishing the E-cadherin and β -catenin adherent connections, inducing apoptotic signals (measured in-vitro and in vivo), and changing the HSP structure, promoting expression of HSP70 on the cell-membrane. These biophysical effects could lead to the intensive distortion of the malignant tissue. The method could be combined with any other oncotherapies (including chemo-, radio-, surgery-, or other therapies as well), and it has low level of side-effects and rare contraindications. Various proofs and facts will be presented from the laboratory to the clinical application.

Conclusion: Modulated electro-hyperthermia is a scientifically established, effective new technique for the old hyperthermia approach in oncology.