WHAT DO WE MEAN "HEATING-UP THE TUMOR"?

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Introduction, Objective

Hyperthermia in oncology has very controversial judgments and opposite reasoning among clinicians. However, the mainly historical results and the supposed universal ability to complement all the existing traditional methods are not enough to prove its efficacy on the evidence based level. Although the temperature measurement is not satisfactorily solved in tumors, it is regarded as the quality parameter and a comparison basis of various hyperthermia techniques. Terms "heat-dose", "temperature", "energy dose" are used frequently as synonyms. We address the question: what we really mean on heating up the tumor?

Method

The dose thinking expects a value, which is volume/mass dependent, its proportioning could depend on the actual area/volume/mass. The temperature as a thermodynamic parameter measures an area/volume/mass independent equilibrium situation, expect isotherm-characterization of the tumor, supposing the only temperature changes in the area due to the "heating-process. However, the energy pumped into the tumor are is consumed by numerous effects which modify the temperature differently than a simple heating of a lifeless material (phantom). The trivially presented physiology reacts and drastically modifies the energy distribution: the blood-flow the metabolic rate, the electrolyte concentrations, pH and charge-distribution changes, lipid reactions and protein syntheses (HSP) are stimulated by the actual energy-intake. All these processes are energy-consuming, and their energy will be missing from the simple unchanged phantom-calculations. Nevertheless, some assumptions and corrective calculations could approximate these effects and modify the actual phantom-compared situation. However, an important factor, for what the treatment exists, is not calculated: the energy, which we expend on the distortion of the tumor structure and the malignant cells! Despite of the very complicated temperature equivalence standardization [1], [2], the scientific considerations [3], as well as the clinical experiences [4], well demonstrate the limit of the temperature control alone. The uncalculated and unmeasured missing incorporated energy is responsible for the curative hyperthermic changes in the tumor, and neglecting this could also explain numerous controversial results.

Discussion

Theoretical considerations showed the problem of the temperature dose-concept, and calculated a temperature dependent correction, about $2^{o}C$ at 42.5, [5]. On the other hand, it is shown [6], that the thermal energy does not limit the electromagnetic effects through the membranes in the tissue. Our main approach is to use the constrained heat-flow through the cellular membranes of the malignant cells, forcing extra ionic currents and electro-osmotic processes to damage the membrane [7]. This situation technically could be constructed by capacitive coupling [8], using the impedance selection for focusing and the forced heat flow by non-equal specific absorption rate [SAR] in microscopic regions. The treatment is safe and well reproducible, [9].

Conclusion – Over-estimating the role of temperature damages the progress of the oncologic hyperthermia and simultaneously makes the treatments extremely complicated and expensive. The quantitative quality control by the absorbed energy combined by the ionic concentration and mobility (impedance measurements) could be a method of control with acceptable complexity. It is time to think differently: study and apply the non-equilibrium processes during the heating procedure.

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