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Electro-Hyperthermia: A New Treatment in Oncology

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Objectives

Although hyperthermia treatment in oncology is widely known, few consider it an effective mainstream treatment due to its negative effects. However, a new method, *electro-hyperthermia*, is capable of harnessing the advantages of hyperthermia, while reducing the negative effects that render most traditional hyperthermia treatments ineffective. This review will introduce electro-hyperthermia and compare it with the more traditional hyperthermia treatments.

Background — Hyperthermia

The effects of traditional hyperthermia are well known. Some of the more important advantages and disadvantages are summarized in Table 1.

Table 1. Biological Effects of Traditional Hyperthermia [1]

Positive Effects	*Negative Effects*
• Dividing cells (e.g. cancer cells), are more sensitive to heat, • Heat speeds up metabolism forcing tumors to use less efficient anaerobic pathways, • Low pH caused by anaerobic processes leads to acidosis, • Increased metabolism sensitizes the cells to chemo- and radiotherapy, • Hyperthermia primarily targets poorly oxygenated tissues thus complementing chemo- and radiotherapy.	• Produces heat-shock proteins that protect the cells against damage, • May aid in the development of resistance against chemo- and/or radiotherapy, • May stimulate metastases formation, • Deep-heat delivery and focusing is a complex bioengineering problem.

Most hyperthermia treatments heat an entire region, including the cells within the targeted tissue. The cells, however, produce stress-proteins (chaperons) in response to heat, in an attempt to adapt to the stress and prevent significant damage caused by the treatment. Malignant tissue can therefore develop resistance against heat, and can significantly reduce the effectiveness of hyperthermia. Furthermore, the stress proteins, induced by hyperthermia, can reduce the chemo- and radio-sensitivity of the cells; thus eliciting a negative effect [2].

Electro-Hyperthermia

Electro-hyperthermia (EHY) has been developed to increase selectivity and reduce the disadvantages of traditional hyperthermia. EHY differs from other hyperthermia treatments by selectively heating the extracellular matrix (ECM) of the targeted tissue rather than the cells. The aim is to rapture the cell membrane, as well as to affect the voltage gated ionic channels, without creating high stresses inside the cell. By the time high stress levels reach the interior of the cell by slow heat diffusion, the damage to the cell is irreversible, causing cell death without the production of stress proteins. The first three disadvantages of classical hyperthermia are therefore eliminated. EHY also offers easy applicability to most organs (including brain, sexual organs, pancreas, etc.) and is more tolerable for patients than other treatments. Finally, it has improved coupling with other treatments (e.g. chemotherapy, radiotherapy, and surgery) and may block angiogenesis.

Conclusions

Based on this theory, several electro-hyperthermia devices have been developed to target a wide range of malignant sites with great success: a DC system for surface treatments, an AC device for intracavital treatments, and an RF-capacitive coupling system for deep-seated tumor treatments. The clinical results from these treatments show a drastic improvement over existing methods.

References

[1] Urano, M., Douple, E. (1988) Thermal effects on cells and tissues. Hyperthermia and Oncology. VSP, Utrecht, The Netherlands.

[2] Li, G.C., Mivechi, N.F., Weitzel, G. (1995) Heat shock proteins: Thermotolerance and their relevance to clinical hyperthermia. Int. J. Hyperthermia, 11:459-488.