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Therapeutic Applications of Electromagnetic Fields -Battles against Cancer with Medical People-

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There are different approaches to cancer treatment such as surgery, radiotherapy, chemotherapy, gene therapy, immunotherapy, electrochemotherapy, hyperthermia and ablation. Two or more different ways are sometimes combined for better clinical outcome. Electromagnetic field (EMF) technology has greatly contributed to cancer treatment with collaboration of medical people. Hyperthermia and ablation, sometimes referred to as thermal therapies, employ thermal effect of EMF. On the contrary, electrochemotherapy is one of typical techniques based on non-thermal effect of EMF.

Hyperthermia utilizes the difference of thermal sensitivity between tumor and healthy tissue. Generally, the target tumor is heated up to the therapeutic temperature, between 42 and 45°C, without overheating the surrounding normal tissues. When combined with hyperthermia, the efficacy of other ways such as radiotherapy and chemotherapy can be enhanced, and their dose can be reduced. Heating scheme is divided into two types: external heating and internal heating. For the case of localized and deep-seated tumors, internal microwave heating seems to be an appropriate method. With this technique, an array of thin antennas is inserted into the tumor and radiates microwave energy directly into the target.

Ablation has been applied mainly for treatment of small-sized tumors such as hepatocellular carcinoma. During the treatment, a thin electrode or a microwave antenna is directly inserted into the tumor to produce heated region with temperature well over 60 °C and its treatment time is usually around a few minutes, much shorter than hyperthermia treatment. Recently, image-guided ablation has been widely used to further improve QOL (quality of life) of patients and to ease an operation for medical doctors.

Unlike antennas for telecommunications, SAR (specific absorption rate) and temperature distributions in a human body are essential parameters of antennas for thermal therapies. The author's group developed so-called coaxial-slot antennas, which have been used for actual clinical treatments.

It is almost impossible to use real human bodies to experimentally evaluate performances of implantable devices such as coaxial-slot antennas. Instead, computer simulation is usually performed with sophisticated digital human-body models. However, experiments with human-body physical phantoms are indispensable to validate the results of numerical simulations or to minimize animal experiments.

Finally, a couple of further challenges will be addressed at the presentation including theranostics that means a combination of therapeutics and diagnostics.