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Hyperthermia and radiation therapy: potentials for synergy and future developments
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For the future success of clinical hyperthermia in multimodal cancer therapy specifically in combination with radiotherapy a concentrated and coordinated effort in all domains is needed. Input must come from biology (e.g. thermoradiobiology, thermoimmunonology), medical physics (e.g. noninvasive thermometry, treatment planning), engineering (e.g. novel hardware for intensity modulated hyperthermia and image guided hyperthermia), IT (e.g. optimization and synergy of RT and HT-workflow); and clinics (phase I/II study in large animal with spontaneous tumors and for human patients with novel technology, multicenter/international randomized phase III studies for common tumours with stringent QA criteria).

Key issues are:
1. Why, despite a sound thermoradiobiological rationale is clinical implementation of HT so slow?
2. Why is innovation and progress in the development of timely hardware and software technology so slow, specifically if compared to the recent progress in radiation oncology technology?
3. Why did hyperthermia not get a better integration into clinical protocols using state of the art radiation therapy technology?
4. What are the promises of thermoablative procedures like HIFU, RFA, or nanotechnology based hyperthermia compared to classical regional (capacitive or radiative) hyperthermia used as physical radio sensitizer?

An international coordinated effort is needed with active participation of all stakeholders. Local institutional innovations are desperately needed from interested industrial partners, academic centers focusing on technology development and academic centers focusing on novel clinical trial design. This could provide optimal synergism and pave the way toward implementation of oncology hyperthermia as a standard treatment modality within multimodal cancer therapy.

SP-0299
Technical aspects of hyperthermia: present and future
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Hyperthermia methods can be subdivided into local, locoregional and whole body heating, and in different temperature ranges either aiming for direct ablation (T>55°C, only for local heating) or for radiosensitization and chemosensitization (39°C<T<43°C, all three categories). The application of hyperthermia should always be guided by sufficient thermometry during treatment to ensure that the intended thermal dose is given to the entire target region. This is challenging due to tissue and blood flow heterogeneities which can affect the uniformity of the thermal dose distribution.

Achieving a uniform temperature rise of 39-42°C is straightforward for whole body heating techniques, but more challenging for local and locoregional hyperthermia. Most clinical hyperthermia equipment uses radiofrequency (RF) and microwave (MW) antennas for local and locoregional heating of tumors. Deep seated tumors are heated with phased arrays of RF/MW antennas. The frequencies of 70-150MHz used for heating deep seated tumors result in heating of the tumor and a large margin around the tumor. The trend is to increase both the frequency and the number of antennas in order to reduce the focus size and thus achieve more selective tumor heating. Temperature measurements are performed with a limited number of invasive temperature probes, these are now increasingly supplemented with non-invasive temperature measurements using MRI and other techniques which yield a 3-D image of the temperature distribution.

Tumor ablation is achieved with invasive interstitial RF, MW and ultrasound (US) techniques. A more recent non-invasive technique is High Intensity Focused Ultrasound (HIFU) combined with non-invasive MRI thermometry. HIFU is capable of focusing heating to regions <1cm, the use of HIFU to achieve uniform heating of a large region to 40-43°C is presently investigated.

Reliable hyperthermia treatment planning is important for pre-treatment planning, adaptive planning during treatment and for reconstruction of the given thermal dose distribution after treatment. A challenge for hyperthermia treatment planning is to model both the energy absorption in the tissue and the bio heat transfer by tissue blood flow, and the latter may also change during treatment. The latest planning systems are capable of fast and high resolution computations, sufficiently fast for real time computation during treatment, e.g. to adapt settings in response to changing blood flow values.

Conclusion: hyperthermia equipment is increasingly capable of providing a well-controlled dose distribution similar to standards in radiation oncology. This well-controlled dose distribution is essential in achieving optimal clinical results.

SP-0300
Hyperthermia combined with brachytherapy
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Hyperthermia (HT) serves as a safe adjuvant treatment to radiotherapy in order to enhance its clinical results (radiosensitisation). It causes usually no or minimal injury to normal tissues. The best approach is to deliver hyperthermia and radiation simultaneously, which is difficult in common practice. The above is supported with extensive preclinical data and a number of randomized clinical trials concerning mainly combination of different types of hyperthermia treatment with standard external beam radiotherapy of specific types of cancer. Unfortunately, brachytherapy based HT treatment is quite poorly investigated and these data are scarce. Nevertheless, a short subjective literature review will be presented. Then, some possible clinical applications will be discussed, e.g. superficial or interstitial local/regional HT