Zurich University
of Applied Sciences

School of
Engineering

IR Kamera für die Qualitätsicherung von Applikatoren in der Oberflächenhyperthermie

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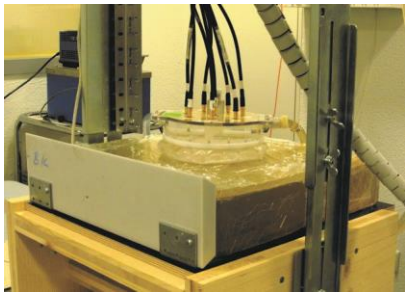
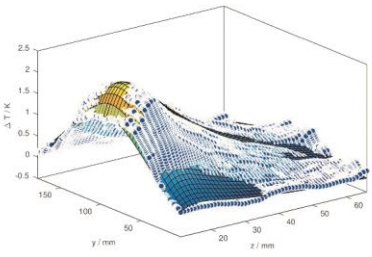
In context of radiation oncology, superficial hyperthermia is applied prior to radiotherapy in order to improve susceptibility of tumorous tissue for ionizing radiation. At Aarau Cantonal Hospital, various applicators with multiphase antenna arrays ranging from 3 to 24 helical antennas are used to direct RF energy at 915 MHz into affected tissue, causing a rise in temperature up to 41-43 ◦C for extended periods of approximately 75 minutes.
For quality control purposes, each applicator's performance at heating tissue needs to be periodically assessed. In a new set of quality control guidelines, local temperature rise in a tissue equivalent phantom shall be determined using infrared thermography. Temperature difference prior to and after RF heating is acquired in two layers orthogonal and parallel to the applicator surface.
A suitable experimental setup has been designed and built in order to determine effective field size EFS and effective heating depth EHD according to ESHO guidelines for the applicators available. For verification of the thermographic imaging method and determining thermal emissivity of the phantom material, fiber optical temperature probes have been used for acquisition of linear temperature profiles in parallel with thermal imaging. A numerical model for RF absorption and thermal conduction inside the phantom material has been developed based on experimental data. Impact of parameters such as water bolus thickness, temperature and temperature decay on accuracy and practical application of the guideline have been examined independently, based on model data. A perfused multilayer tissue model was implemented for in-silico determination of the heating pattern and biological effect of hyperthermia treatment, using a CEM43-iso-dose model for tissue damage.
Temperature distribution in a static phantom has been found to be an acceptable match for simulated thermal dosage distribution in perfused tissue, allowing usage as an additional tool in treatment planning. For technical quality control, thermal imaging provides benefits in regards of good spatial resolution, scalability and short process times.



SA-812 hyperthermia applicator with experimental setup and tissue equivalent phantom



Heating pattern for SA-812 applicator perpendicular to phantom surface