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MONITORING OF KEY PARAMETERS DURING THERMOGRAPHY-CONTROLLED WIRA-HYPERTHERMIA IN THE TREATMENT OF SUPERFICIAL TUMORS

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Abstract Text: Introduction: Accompanying the clinical application of thermography-controlled wIRA-hyperthermia (wIRA-HT) immediately followed by hypofractionated re-irradiation (re-RT) of recurrent breast cancer, we have investigated a series of features which may impact treatment efficacy. These features included thermographic control, invasive measurement of tissue temperatures, assessment of effective heating depth, calculation of SAR values, and tissue oxygenation monitoring. Furthermore, the role of pathologies occurring with breast cancer (e.g., fibrin deposition, bleeding ulcers, plasma exudation, and scurf formation) was investigated for refining the wIRA-HT treatment protocol (Notter et al., IJH 2017).

Methods: For wIRA-HT, two radiators, controlled independently by two thermographic cameras and safety pyrometers (hydrosun®-TWH1500, Hydrosun Medizintechnik, Müllheim, Germany) were used. Invasive temperature probes (OTG-600, Opsens, Quebec, Canada) were positioned in defined depths of the abdominal wall of healthy volunteers (AT, MS) to assess the temperature field upon wIRA-HT treatment. For oxygenation monitoring in superficial tissue/tumor layers, a hyperspectral imaging system (TIVITA®, Diaspective Vision, Am Salzhaff, Germany) was used. Pathological conditions were simulated by deposits of fibrin clots, plasma exudates and blood incrustation. Simulations included measurements of IR emission factors and optical densities of these pathologies.

Results: Considering HT levels required in the clinical setting (39-43°C, Kok et al., IJO, 2019), we could confirm effective wIRA-heating depths of 25 mm (T ≥39°C), 20 mm (T ≥39.5°C), 15 mm (T ≥ 40°C), and 10 mm (T ≥40.5°C, for details see Vaupel et al., IJH 2018). Calculated mean SAR values and blood flow rates are presented in the Table. Mean O2 saturation values were 39 sat.% before wIRA-HT, 77 sat.% at the end of wIRA treatment, with a steady decline thereafter, reaching 62 sat.% after 30 min, i.e. O2 saturation doubled during treatment and remained at significantly elevated levels during re-RT (see Fig). Compared to intact skin surface, exudations reduced net energy delivery of wIRA to the underlying tissue due to increased evaporation. This effect can be eliminated by covering with thin polyethylene foil or transparent film dressings.

Conclusion: Considering the above information may further improve the therapeutic efficacy of the wIRA system used.