THE HYPERCOLLAR: A NOVEL PHASED-ARRAY APPLICATOR FOR HYPERTHERMIA TREATMENT IN THE NECK

Paulides M.M.¹, Bakker J.F.¹, Neufeld E.², Jansen P.P.¹, Levendag P.C.¹, Van der Zee J.¹ and Van Rhoon G.C.¹.

¹ Erasmus MC – Daniel den Hoed Cancer Center, Rotterdam, The Netherlands.
² IT’IS Foundation, Zurich, Switzerland

Purpose: Clinical phase III trials have established the benefit from adding hyperthermia (HT) to radiotherapy (RT). The possibilities of HT are interesting to study in advanced head and neck tumours as well, however, an appropriate applicator is not available. Therefore this work was directed at the design and construction of a HT applicator for heating of advanced carcinomas in the entire head and neck region.

Materials and methods: High-resolution 3D electromagnetic (EM) simulations were used to perform parameters studies to guide the design of the applicator. Investigated topics were: 1) operating frequency, 2) number of sources, 3) positioning of sources, 4) antenna design. A laboratory prototype was build to verify the possibilities of deep heating with the designed array. In a next step we build a clinical prototype (HYPERcollar) and measured the performance of the final antenna design. We also performed comfort tests by seven healthy volunteers. By treatment planning in SEMCAD X for laryngeal patients, and an oropharynx case (Figure 1), we investigated the specific absorption rate (SAR) patterns that will be possible in patients using the HYPERcollar.

Results: The comfort tests with healthy volunteers have revealed that the applicator provides sufficient comfort to maintain in treatment position for an hour. Using treatment planning we showed that the focus can effectively be steered towards a target region or even multiple target regions, e.g. a primary tumour and a lymphnode metastasis (Figure 2). Further, we showed that by adjusting the SAR optimisation settings we can effectively reduce the SAR level in the critical tissues.

Conclusion: A site-specific applicator was designed that enables a good control of the SAR pattern. A clinical feasibility study is ongoing.

Figure 1: SAR distribution in an example oropharynx patient (black = 0%, white = 100%).

Figure 2: Optimised 25% iso-SAR volume coverage (white) of a primary larynx tumour (red) and an artificial lymphnode metastasis (red sphere). Further visible are the bony structures (yellow).