

HYPERTHERMIA TREATMENT PLANNING: REAL-TIME CLINICAL USE OF MODEL GUIDED STEERING

Canters R.A.M.*; Franckena M.*; Van der Zee J.* and Van Rhoon G.C.*
Erasmus MC – Daniel den Hoed Cancer Center, Rotterdam, The Netherlands
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Introduction and purpose

Current hyperthermia treatment of cervical carcinoma makes use of an empirical steering protocol. On patient complaints the focus is shifted away from the complaint region. Optimized treatment, using model guided steering, is based on a real anatomy model. This type of steering is tested in a clinical study in patient treatments. First purpose of this study is testing the feasibility of real-time model guided steering using optimization in a clinical setting and a comparison of tumor temperature between model guided and regular treatments. Secondary a reduction of patient complaints is a goal of the study.

Methods

The basis for treatment planning is the Hyperplan FEM-model. Additionally a dedicated optimization routine, maximizing SAR in the target area, is developed in our department. Two possible goal functions are tested in the study. The first goal function optimizes target-SAR without taking into account possible hotspots. Only on patient complaints the objective function is adapted to reduce hotspots. The second optimization goal function takes into account hotspot in initial optimization. On complaints in a certain region the goal function is also adapted to give more weight to the concerning region. Before the use in a clinical situation these goal functions are tested in a phantom test setup to evaluate the effectiveness of steering actions.

Treatment of patients starts with optimized settings. On complaints, in the goal function more weight is given to the complaint region, after which optimization is recalculated and new settings are applied.

Results

Phantom tests indicate that most effective steering is achieved in peripheral regions. In regions adjacent to the target, reduction is less.

Results of treatments performed with both optimization routines show the feasibility of real-time clinical use of model guided steering. Calculation times are less than one minute generally, which is fast enough for (almost) real-time adaptation of settings on patient complaints. Furthermore temperatures well within the therapeutic range, above 41°C in target region, are achieved during treatments using optimization.

At last, in temperature models results of different patients are compared for regular treatment settings and both optimization methods. On basis of these model better results in temperature are expected. Model temperature predictions for regular treatment and both optimization routines show expected temperature differences in the order of tenths of °C.

Conclusions

Real-time SAR-optimization has shown its feasibility in a clinical study. Results of a number of treatments show that intraluminal temperatures well within therapeutic range can be achieved. Model predictions furthermore indicate an increase in tumor temperature using optimization treatment planning.