E-field Measurements in the Sigma-60 Water Bolus for Antenna Feed Point Correction

Daniel de Jong[1*], M.M. Paulides and G.C. van Rhoon
[1]Erasmus Medical Center, Rotterdam, The Netherlands
[*]d.dejong@erasmusmc.nl

INTRODUCTION

In hyperthermia treatment planning, accurate translation of the predicted SAR distribution from monitor to patient is still a critical aspect. Mismatch between predicted and actual applied SAR distribution can be reduced substantially by minimizing positioning errors and apply correct phase & amplitude settings at the feed point of the antennas. Integration of an ultrasound detector at the central plane of the applicator is a straight forward approach to reduce positioning errors. Alternatively, in a hybrid BSD2000-3D-MRI system a partial body MR-scan at start of treatment can provide accurate information on the exact position of the patient.

Gellermann et al [Med. Phys. 2006] demonstrated that applying feed point correction can halve the mismatch between "Hyperplan" predicted and MRI measured SAR distribution in phantoms. Phase displacement as high as 30-45° were reported. Additional amplitude correction in the feed point further reduced the error between planning and measurement to below 10%. It is still unclear, whether this methods can be applied during patient settings as SAR measurement during treatment is more complicated.

In this study, we theoretically demonstrate that a similar effect of phase & amplitude feed point correction can be obtained by matching the E-field distribution as measured by a distinct number of fiber optic (FO) E-field sensors in the water bolus of the Sigma-60 applicator. The distortion of the E-field distribution investigated is due to a more inward curvature of the water bolus compared by the anticipated predicted set-up.

MATERIALS AND METHODS

In our approach we considered measurement of the actual E-field at 8 virtual FO-E-field sensors in the water bolus of the Sigma-60 applicator, equally circular distributed around the patient. From subsequent matching of measured and predicted E-fields at these 8 locations, using an earlier obtained "calibration" E-field distribution matrix, we could calculate corrected phase & amplitude settings in the antenna feed points for the set-up with the inward curved water bolus.

RESULTS

The resulting SAR distribution with the corrected feed point setting is in close agreement with the standard water bolus, i.e. the 25% iso-SAR contour coverage difference is below 5%. As the cost of this FO_E-field sensor is relatively low, it is possible to integrate multiple FO_E-field sensors in the water bolus to continuously measure the actual E-field distribution and enable fast automatic correction of phase and amplitude settings in the antenna feed points.

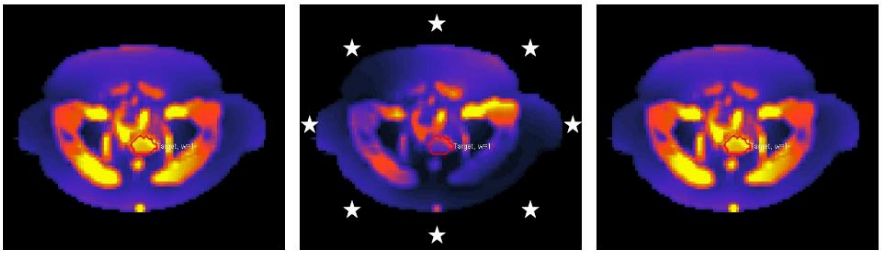

Figure 1: 25% iso-SAR profile for the original planning (left), a more inward curved water bolus (middle) and after correction of the E-field at 8 locations as indicated by the asterisks (right).

CONCLUSIONS

This study shows the potential of E-field measurements in the water bolus to help reducing the error introduced by deviating water bolus curvatures with respect to the original planning.

ACKNOWLEDGMENTS

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REFERENCES

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