

A HEAD AND NECK HYPERTHERMIA APPLICATOR: THEORETICAL ANTENNA ARRAY DESIGN

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Introduction

Hyperthermia (HT) has a high potential to improve treatment results in Head and Neck (H&N) patients. However, an appropriate applicator that can heat both superficial and deep located target regions is not available. In previous studies^{1 2} we investigated the possibilities of focussed RF HT for the neck region. We found that a setup of six to eight antennas, operating at 433MHz, can be used to obtain the desired power absorption (PA) pattern in the neck. In the present study we extend the previous work and converge towards one array setup, with multiple antenna rings, that meets the clinical demands. Hereto we investigated the ability to deposit RF-energy centrally in the neck as a function of patient positioning, antenna ring radius (R), number of antenna rings, number of antennas per ring and distance between the outer antenna rings (D).

Materials and methods

PA distributions in two realistic (small and large patient) anatomy models were calculated. These head models were irradiated by several configurations utilising one, two or three circular arrays consisting of four to eight antennas, i.e. 1x8, 2x4, 2x6, 2x8 and 3x4 arrangements. The relative PA distributions corresponding to different set-ups were visualised and analysed using the ratio of the average PA (aPA) in the central target region and neck region.

Results

Proper patient positioning was found to be highly important for a high aPA (~30% variation). For an increasing ring radius (12.5-25cm) we found a 15% decrease in aPA. Increase of the number of antenna rings from one to two or three led to around 20% more power focussing. aPA ratios remained approximately stable for $D \leq 6\text{cm}$ but decreased for $D > 6\text{cm}$ due to a decreased central power intensity. aPA ratios were comparable for a 2x6 and 3x4 arrangement and only a moderate increase was observed for a 2x8 arrangement.

Conclusions

A single optimum array setup for all patients remains difficult to define since this is highly dependent on anatomy and target locations. Based on the aPA results, practical limitations and potential for axial steering, we selected a 2x6 setup with $R = 20\text{cm}$ and $D = 6\text{cm}$ for the clinical applicator design.

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References

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