A PATCH ANTENNA ELEMENT FOR THE HYPERCOLLAR APPLICATOR: DESIGN AND CHARACTERIZATION

Paulides M.M.[1], Bakker J.F.[1], Chavannes N.[2], Van Rhoon G.C.[1]
[1] *Erasmus MC – Daniel den Hoed Cancer Center, Rotterdam, The Netherlands.*
[2] *Schmid and Partner Engineering (Speag), Zurich, Switzerland.*

Purpose: 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 we found that a setup consisting of two rings of six antennas, operating at 433MHz, can be used to obtain the desired specific absorption rate (SAR) pattern in the neck. In the present study we describe the design of the single antenna element, i.e. a probe-fed patch antenna. Further we analysed the characteristics of the antenna within the HYPERcollar.

Methods: As a first step, we selected the probe-fed patch antenna as most promising candidate and changed its design to meet the desired requirements for operation in a water environment. Using electromagnetic modeling tools (Ansoft Designer and SEMCAD X) we optimized the dimensions of a probe-fed patch antenna design for operation at 433MHz. The electrical properties of the optimized design were analyzed by using SEMCAD X. Further we conducted reflection measurements to verify the simulations and to investigate the properties of the antenna within the array.

Results: By several optimization steps we could converge to a theoretical reflection of -38dB and a bandwidth (-15dB) of 20MHz (4.6%). Theoretically, the electrical performance of the antenna was satisfactory over a waterbolus temperature range of 15-35°C, and stable for patient-antenna distances to as low as 4cm. In an experimental cylindrical setup using six elements of the final patch design, we measured the impedance characteristics of the antenna 1) to establish its performance in the applicator and 2) to validate the simulations. For this experimental setup we simulated and measured comparable values: -21dB reflection at 433.92MHz and a bandwidth of 18.5MHz. We further established that indeed operation between 15-35°C is possible when maximum 10% reflection is allowed

Conclusion: On the basis of this study, we conclude that this patch antenna design is very suitable for the clinical antenna array. In future research we will verify the long duration electrical performance by measurements in a clinical feasibility study.

Figure 1: 3D configuration (left) and cross-section (right) of the patch antenna configuration and a cross-section, with the dimensions that are varied. The "Muscle layer" was present only in the setups that were used to investigate influence of a patient on the reflection characteristics.