Improved regional hyperthermia delivery by using MRI data for treatment planning

1 Members project group: project leaders Hans Crezee, Aart Nederveen, Lukas Stalpers. PhD student Edmond Balidemaj. Other staff involved Petra Kok, from UMCU Nico van den Berg and Astrid van Lier.

2 Sponsor: KWF (UVA 2010-4660)

3 Background:
Hyperthermia (HT) is a powerful, clinically proven radiosensitizer. Regional hyperthermia for pelvic tumors, including cervical, rectal, bladder and prostate carcinoma, is applied using phased arrays of multiple Microwave (MW) or Radiofrequent (RF) antennas. A challenge in achieving high tumor temperatures is avoiding excessive normal tissue heating, or so-called hot spots. Hot spots are related to anatomical structures, specifically interfaces of tissues with different power absorption rates (SAR). Establishing optimal antenna settings preventing hot spots is complex due to tissue and perfusion heterogeneity and the large number of antennas. This task is performed using Hyperthermia Treatment Planning (HTP), but the accuracy of present tissue input data is limited and the computed system settings are thus not optimal, leading to treatment limiting hot spots and suboptimal tumor temperatures.

4 Purpose
We will improve the reliability of HTP by replacing the presently used generic literature values for dielectric tissue properties by patient specific data based on MR imaging as input for HTP. This will yield a more reliable prediction of hot spot location and amplitude, and thus yield system settings resulting in higher tumor temperatures and less toxicity.

5 Plan of investigation:
Step 1 is development of a MRI dielectric imaging (MRI-DI) technique, followed by step 2, experimental validation of the reliability of the MRI-DI data acquisition method using phantom materials and tissue samples with known dielectric values verified with an impedance probe, and clinically in 20 patients with cervix tumors eligible for HT treatment. Prior to HT anatomical data acquisition will be performed for each patient in two ways: Firstly with the traditional CT image based segmentation method and secondly with the MRI-DI method. Comparison will reveal which data acquisition method yields the most accurate prediction of location and amplitude of hot spots. The impact on tumor SAR and tumor temperature will be recorded.

7 Contact name: Hans Crezee

6 Selected publications (12345)

References


Phantom measurements for $\sigma=0.04$ to $\sigma=2.0$ S/m.

In vivo measurements (thighs).