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NON-INVASIVE MRI-GUIDED HYPERTHERMIA OF DEEP TISSUE

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A new system of radiofrequency (RF) applicators operating at 13.56 MHz is being developed to apply hyperthermia (HT) for adjuvant therapy in the treatment of pancreatic cancer. Because administering thermal therapies to deep tissues is currently limited by a lack of temperature monitoring that is both non-invasive and accurate, the system is being designed to operate in an MRI scanner operating at 123 MHz. The most common form of magnetic resonance thermometry (MRT) employs the proton resonant frequency shift. Unfortunately, extended MRT is subject to severe magnetic field drift, a systemic error of the MRI scanner itself, resulting in temperature errors on the order of several degrees. In addition, the HT system will pose an electromagnetic compatibility concern with the MRI system. In this study, we investigated methods to improve the accuracy of MRT as well as to help decouple the RF heating coils of the HT system from the RF imaging coils of the MRI system. To improve accuracy, we employed polydimethylsiloxane as a reference for the magnetic field drift. The reference was subtracted from the uncorrected temperatures, reducing the root-mean square error from approximately 14 °C to less than 0.6 °C. To improve electromagnetic compatibility, a selective RF shield was employed to mitigate interactions between the two systems. The operating frequency of the HT system is attenuated by 16.79 dB while the operating (imaging) frequency of the MRI system is allowed to pass relatively unhindered (-0.37 dB). Future work will include a method for mitigating the effects of motion due to respiration and/or peristalsis. Overall, this research serves as a milestone towards the wide use of thermal therapies in the clinic. This is of particular importance for cancer research as HT in conjunction with radiation therapy and/or chemotherapy has been shown to increase their efficacy.