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SAR and B_1 Considerations for Multi-Nuclear RF Body Coils

Authors : Ria Forner

Abstract : Introduction: Due to increases in the SNR at 7T and above, it becomes more favourable to make use of X-nuclear imaging. Integrated body coils tuned to 120MHz for 31P, 79MHz for 23Na, and 75 MHz for 13C at 7T were simulated with a human male, female, or child body model to assess strategies of use for metabolic MR imaging in the body. Methods: B1 and SAR efficiencies in the heart, liver, spleen, and kidneys were assessed using numerical simulations over the three frequencies with phase shimming. Results: B1+ efficiency is highly variable over the different organs, particularly for the highest frequency; however, local SAR efficiency remains relatively constant over the frequencies in all subjects. Although the optimal phase settings vary, one generic phase setting can be identified for each frequency at which the penalty in B1+ is at a max of 10%. Discussion: The simulations provide practical strategies for power optimization, B1 management, and maintaining safety. As expected, the B1 field is similar at 75MHz and 79MHz, but reduced at 120MHz. However, the B1 remains relatively constant when normalised by the square root of the peak local SAR. This is in contradiction to generalized SAR considerations of 1H MRI at different field strengths, which is defined by global SAR instead. Conclusion: Although the B1 decreases with frequency, SAR efficiency remains constant throughout the investigated frequency range. It is possible to shim the body coil to obtain a maximum of 10% extra B1+ in a specific organ in a body when compared to a generic setting.

Keywords : birdcage, multi-nuclear, B1 shimming, 7 Tesla MRI, liver, kidneys, heart, spleen
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