Introduction: In preparation for a 14T head-only system planned for installation in Incheon, South Korea, we have performed some numerical examinations of potential challenges, benefits, and hazards at this field strength, particularly RF transmit homogeneity, image homogeneity, SNR, and SAR at 14T as compared to 7T and 3T.

Method: All simulation studies were performed using a Bloch-based MRI simulator [1] able to calculate realistic MR signal, noise, and unaveraged SAR with multichannel transmission and reception. A 2mm resolution human digital phantom (including proton density, T1, and T2 values appropriate for 3T) was input into the Bloch simulator with associated RF electromagnetic fields, pre-calculated for an eight channel transmit and receive volume coil model. The simulations utilized a flip angle determined with adjustment of the overall transmit voltage to maximize the overall image intensity. 2) Method for array image combination: For simulations with input B1 field distribution, fully-sampled array images were acquired and combined using adaptive combination method [4]. To overcome the receive image inhomogeneity artifact, simple postprocessing techniques were used [5].

Results & Discussion: The simulation results predict some important phenomena. As expected, with equal TE and a Tx/Rx volume coil, both B0 and B1 artifacts become more pronounced as field strength increases (Fig.2a-c). With RF shimming on only 8 Tx channels and shorter TE at higher field strengths, relatively good T1 field homogeneity on a single plane and mitigation of B0 artifacts can be achieved, even at 14T (Fig.2d-f). From 3T to 7T to 14T, image SNR improves significantly (Fig.3). Importantly, SAR (Table 1) does not increase as rapidly as SNR when shimmmed, especially from 7T to 14T. This demonstrates an important benefit from 7T to 14T. Although the images weighted with realistic receive field inhomogeneity for 14T (Fig.2g-i) show greater inhomogeneity at 14T, more advanced postprocessing techniques can be utilized to overcome such inhomogeneity. In future work, inclusion of field-specific relaxation properties and coils designed for the specific purpose and field strengths should give more accurate results. Nonetheless, this early investigation shows great promise for human head imaging at 14T.


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