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Investigation of Receive-only Top-Hat Dipole RF Coil for Brain Imaging at 7 Tesla MRI

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I. Introduction

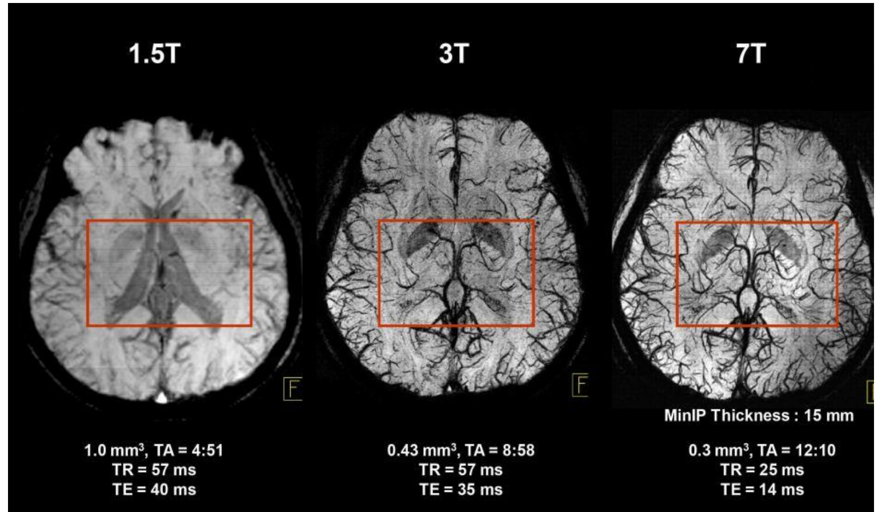
1. Background of Ultrahigh field (UHF) Brain MRI (≥ 7T)

- ✓ High signal-to-noise ratio (SNR),
- ✓ High spectral resolution,

} Pros

- ✓ Small Field-Of-View,
- ✓ Tight and congested imaging area,
- ✓ Low sensitivity in cervical spine.

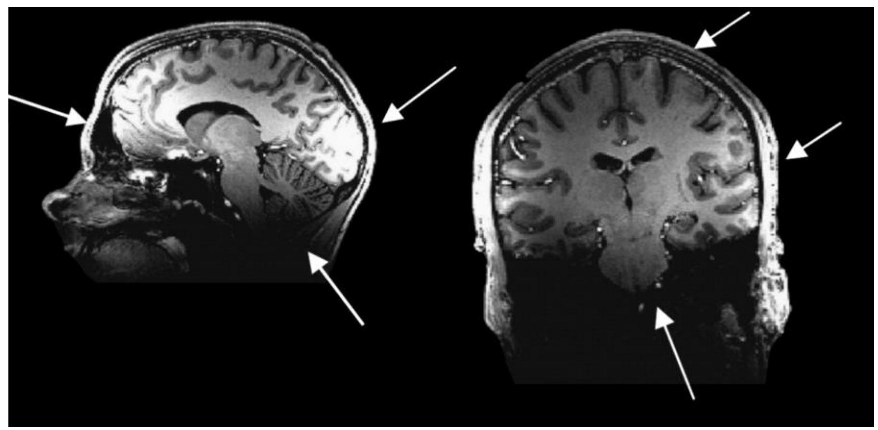
} Cons



Courtesy of Gachon University and Siemens Healthcare

2. Objective

- ✓ Whole brain imaging up to cervical spine with individual RF coil array,
- ✓ Increase in Field-of-view (FOV), spatial coverage and sensitivity,
- ✓ RF coil Optimization based on EM simulation.



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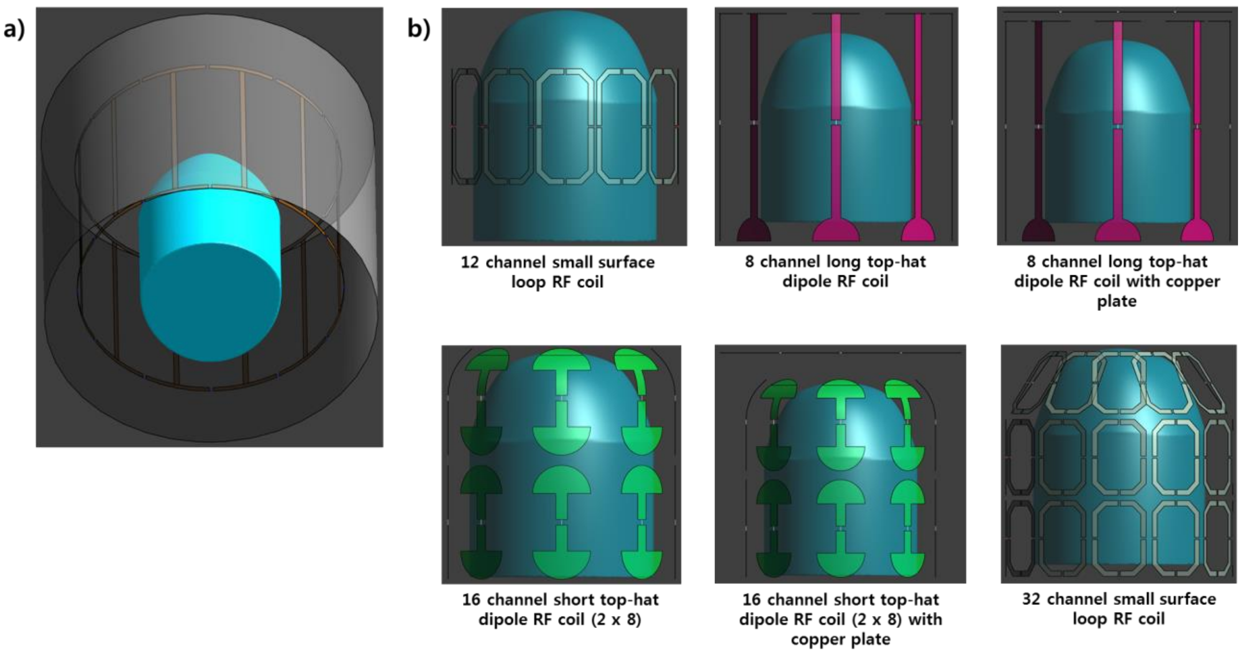
II. Materials & Methods

- Design of Multichannel receiver RF coil arrays based on top-hat dipole antenna.
- In addition, a capacitive copper plate has been implemented to improve the sensitivity in upper region of brain.
- In this study, following RF coil arrays were simulated and studied as shown in figure.



The simulated GRE signal was calculated as following

$$\boldsymbol{SI} \propto \boldsymbol{sin}(|\boldsymbol{B_1^+}| * \boldsymbol{\gamma} * \boldsymbol{\tau}) * \sum \boldsymbol{conj}(\boldsymbol{B_1^-})$$

B_1^+ = transmit B1 field from birdcage RF coil (1.957 µT)
B_1^-= receive B1 field from receiver RF coil arrays
γ = gyromagnetic ratio (42.576 MHz/T)
τ = RF pulse duration (3ms, 90° flip angle).

Figure 1. (a) Transmit highpass birdcage RF coil, (b) Configuration of various receive multichannel RF coils.

III. Results and Discussions

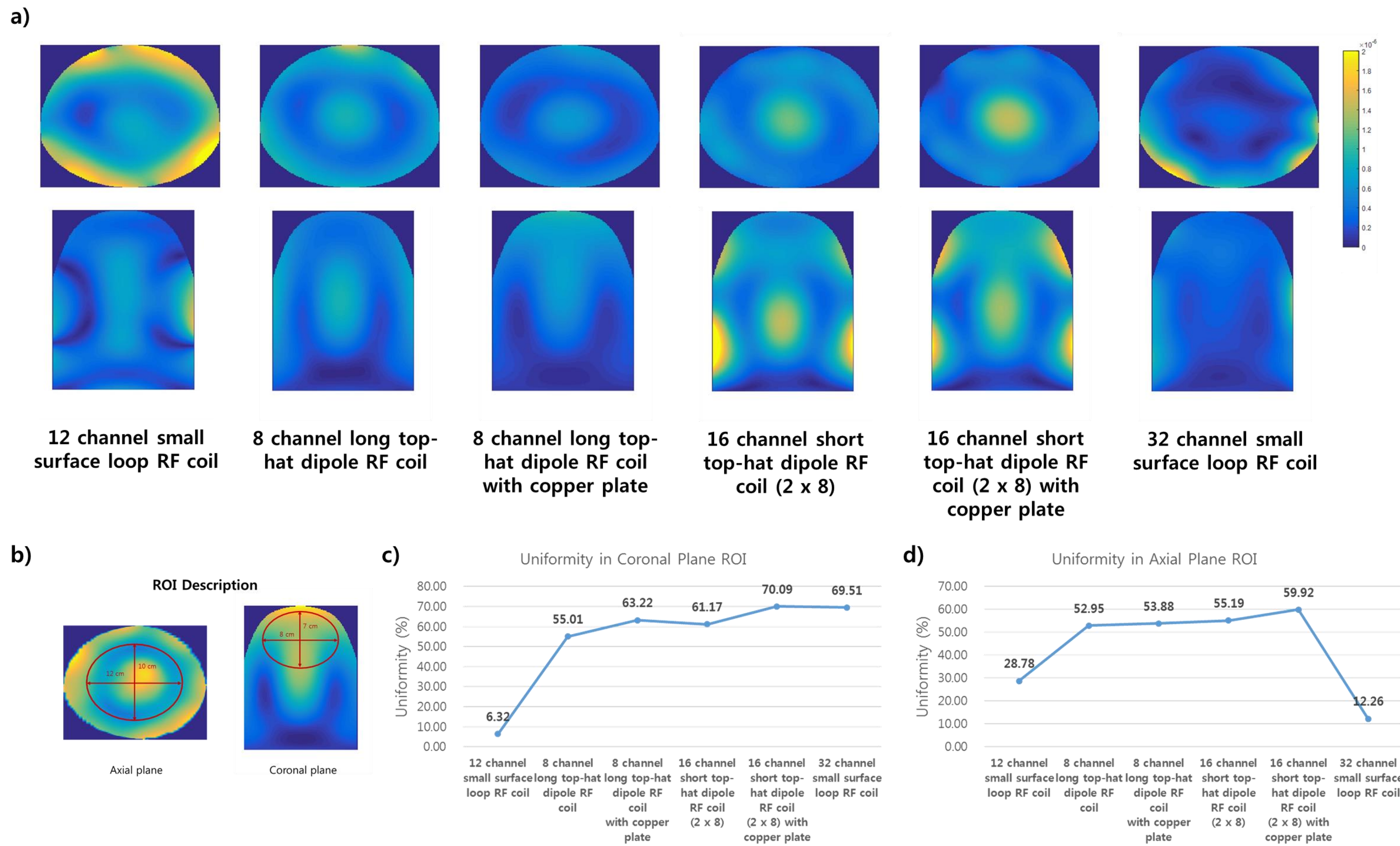


Figure 2. (a) Simulated GRE image in axial (top row) and coronal planes (bottom row), (b) Description of ROI in axial and coronal planes, and uniformity comparison graph in (c) coronal plane ROI and (d) axial plane ROI.

III. Results and Discussions

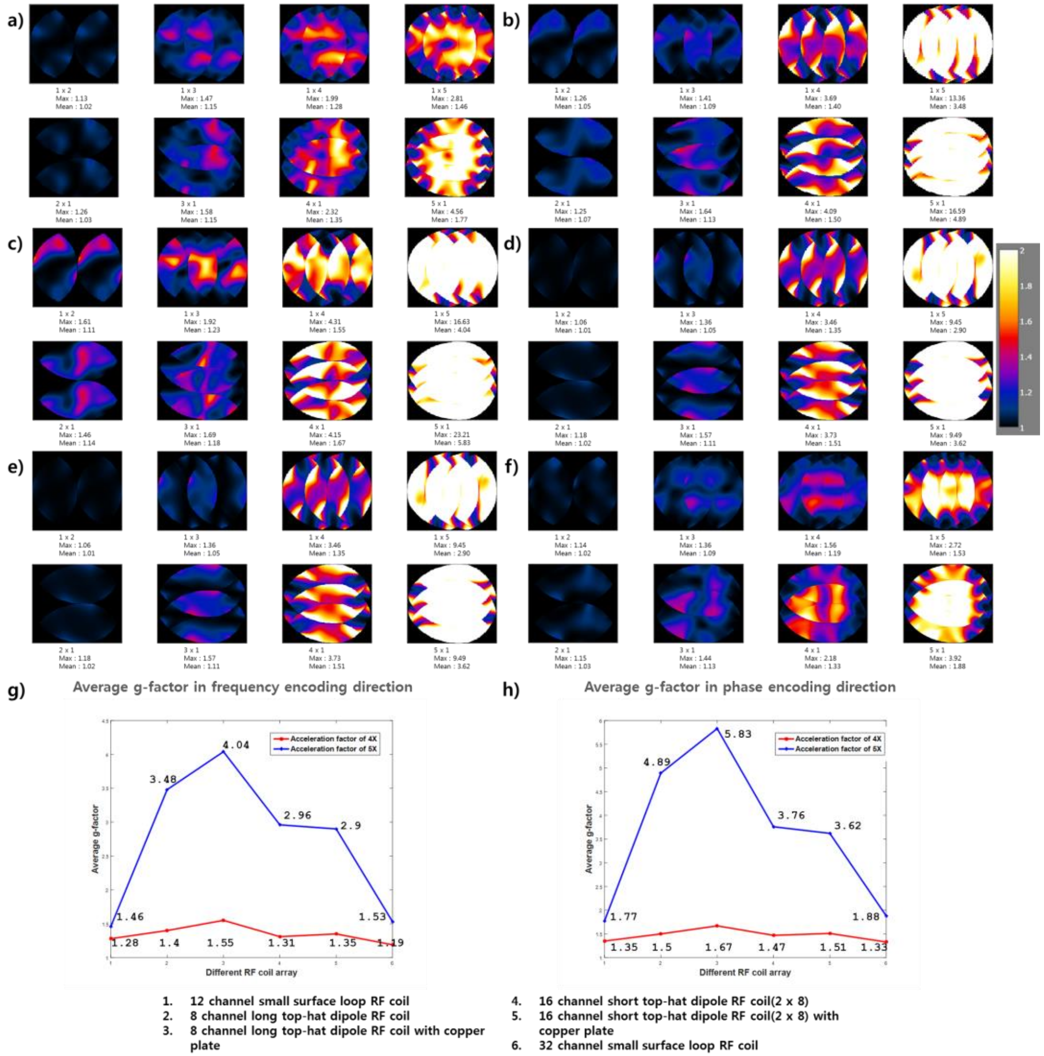


Figure 3. Simulated g-factor maps for various multichannel receiver RF coils in frequency (top row) and phase (bottom row) directions for the acceleration of 2, 3, 4 and 5, and graph representation of the average g-factor in frequency (g) and phase (h) encoding directions for mentioned RF coils.

IV. Conclusions and Future Works

- In conclusion, the top-hat dipole antenna RF coils offers the better B1 sensitivity and uniformity compared to that of 32 channel surface loop RF coil.
- The g-factor simulation shows that the top-hat dipole have acceptable value for 4X acceleration, however slightly higher for 5X.
- **Future work**: 16 channel top-hat dipole antenna RF coil will be constructed and validated through the MRI experiment.

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