Comparison of RF Penetration and G-factor of Different Coil Arrays for Parallel Imaging

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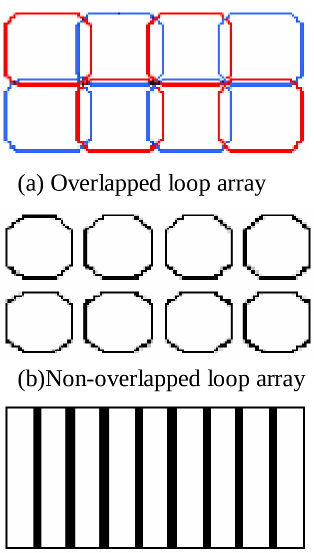
Introduction: Many advanced designs of coil array for high SNR and high speed imaging have been brought forward these years [1-2], but no quantitive comparison among these different designs was reported. In this work, g-factor and RF penetration of three different kinds of eight-element arrays were compared by simulations at the frequency of 220MHz.

Methods: The geometries of three coil arrays are shown in Fig. 1. Each array consists of 8 elements with the same size ((a) 12.5cm×12.5cm, (b) 11cm×8.5cm and (c) 24cm×1cm) and covers the same field of view (FOV), 44cm×24cm.
The objective arrays were modeled using Finite Difference Time Domain (FDTD) method with 5mm resolution and 130x90x120 cells of simulation space to map the B1 field distribution. The coils were all modeled with 1-cm wide copper strip and eight RF sources were used to excite each array. RF penetration of every coil array can be obtained according to their B1 field distributions. The couplings between elements in coil array were neglected during the simulations.
To evaluate their suitability for SENSE imaging, simulations of g-factor were carried out using MATLAB software (R=2), while the sensitivity profiles were calculated based on FDTD method with a FOV of 44cm× 24 cm.

Results and Discussion: The g-maps of coil arrays are shown in Fig. 2. The non-overlapped loop array has the lowest noise enhancement, while the planar strip array shows a poor g-map. The maximum value of g-factor is 1.073 in (a), 1.057 in (b) and 1.247 in (c). For planar strip array, the non-uniform currents along the strips lead to the inhomogeneous B1 field distribution, so the sensitivities far from the feed points are much weaker, which results in the higher noise level. Due to the better orthogonality in sensitivity of the non-overlapped loop array, the overall g-factor is much less than the other two configurations.
The FDTD simulation results for the comparison of RF penetration are shown in Fig3, where the B1 field strength of planar strip array decays faster than the coil arrays with loop structure. For example, at the depth of 60mm, the B1 field strength decreases to 67.4% of the maximum value for overlapped loop array, 44% for non-overlapped loop array, and 24% for planar strip array.
Although the RF penetration of the overlapped loop array is larger than the others, the non-overlapped loop array is more suitable for parallel imaging due to the better orthogonality of the sensitivity profiles. The planar strip array is superior in decoupling performance, but its SNR is lower and more inhomogeneous, and the penetration is smaller. Therefore, compromising imaging quality and speed, the non-overlapped loop array is perhaps a better choice for parallel imaging.

Conclusions: Simulation-based evaluations of g-factor and RF penetration of three kinds of eight-element arrays have been performed. Considering the g-factor and RF penetration, the overlapped and non-overlapped loop arrays are superior to the planar strip array. The overlapped loop array has the best RF penetration, while the non-overlapped loop array is more suitable for parallel imaging among these configurations.

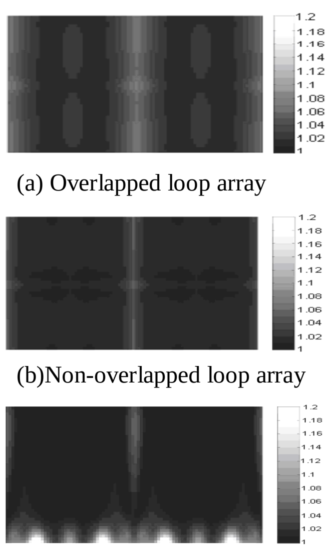


(a) Overlapped loop array

(b)Non-overlapped loop array

(c) Planar strip array

Fig. 1 Geometries of coil arrays



(a) Overlapped loop array

(b)Non-overlapped loop array

(c) Planar strip array

Fig. 2 G-maps of coil arrays

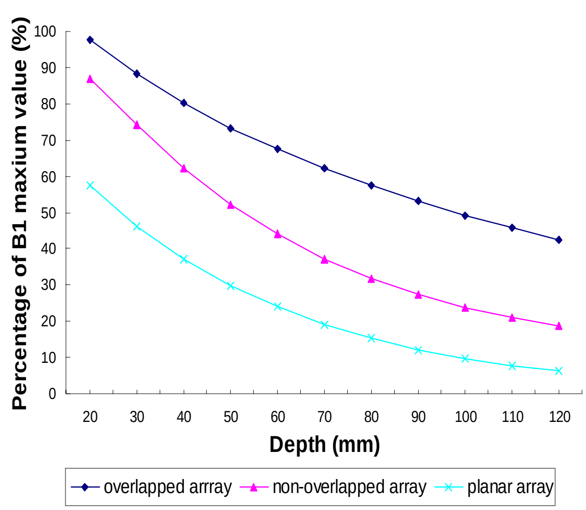


Fig.3 Comparison of RF penetration

References:
[1] P.B.Roemer, et al., MRM 16, 192-225(1990)
[2] Ray F. Lee, et al., MRM 45,673-683(2001)