Gradient coil array for the super-parallel MRI: experimental evaluation

F. Okada[1], S. Handa[1], and K. Kose[1]

[1]Institute of Applied Physics, University of Tsukuba, Tsukuba, Ibaraki, Japan

Introduction

The super-parallel MRI is a concept in which a number of gradient coil sets and RF coils are operated in a large bore (superconducting) magnet to simultaneously acquire MR images of a number of samples (1,2). Recently we have succeeded in extending homogeneous regions of a gradient coil array using the target field method (3). In this study we constructed a gradient coil array for multiple human extremities to accelerate the imaging speed.

Materials and methods

A gradient coil array with two homogeneous gradient field regions was designed (3) and constructed for a permanent magnet (Fig.1). This array was installed to a homebuilt MRI system with a permanent magnet (Fig.2) (4). The specification of the permanent magnet was: magnetic field strength 0.21 T, gap: 25 cm, homogeneity: 50 ppm over 15 cm dsv. The gaps of the gradient coil array were 100 mm and the ratio of the gap to the diameter of the current plane was 1:3.4. The inner aperture of the RF probes was 98 mm × 53 mm. The MRI console had an 8 channel parallel transceiver and two transmitters. 3D spin-echo sequences and gradient-echo sequences were used for evaluation of the gradient coil array. Identical pulse sequences were applied to the gradient coil array and two RF probes. Two NMR signals were simultaneously acquired.

Results and discussion

Efficiencies of the gradient coil array were measured using a water phantom with a 40 mm acrylic sphere. The efficiencies for the first channel were 0.206, 0.209, and 0.490 G/cm/A for Gx, Gy, and Gz and those for the second channel were identical within measurement error. Figure 3 shows cross sections of 3D image datasets of two water phantoms simultaneously acquired using two RF probes. No interference between them was observed. Figure 4 shows cross sections of simultaneously acquired 3D image datasets of wrists of a human subject. Anatomical structures of the wrists are clearly visualized.

The largest advantage of the gradient coil array over the conventional large-gap gradient coil is the efficiency: about 2 times value was observed when the number of turns was normalized. The gradient coil efficiency is essential to visualize small structures in human extremities like musculoskeletal system. In conclusion, the gradient coil array will be useful as an insertable unit for existing whole body MRI systems when multiple human extremities are simultaneously imaged.

Fig.1 Gradient coil array

Fig.2 Super-parallel MRI

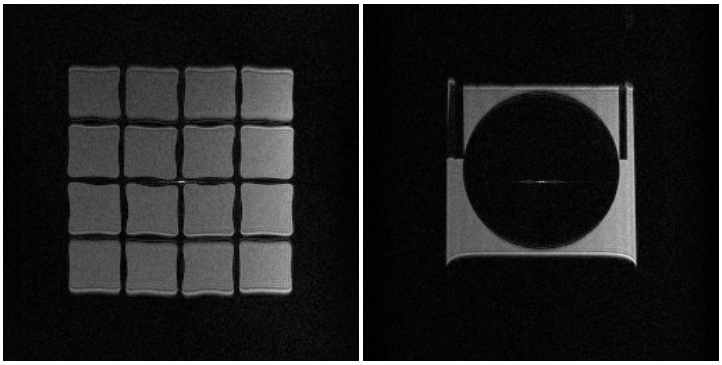

Fig.3 Simultaneously acquired cross sections of water phantoms

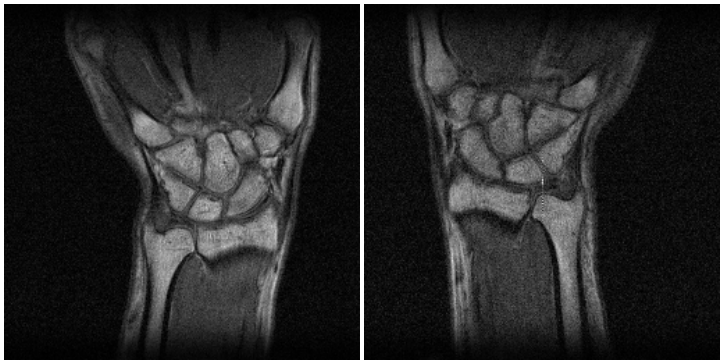

Fig.4 Simultaneously acquired cross sections of wrists

References

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