8-channel linear array gradient probe for the super-parallel MR microscope

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Abstract

A design rule for the gradient probe array in the super-parallel MR microscope was developed. Under this rule, an 8-channel linear array probe was constructed and applied for simultaneous image acquisition of eight chemically fixed human embryos at 100 MHz.

Introduction

The super-parallel MR microscope (SPMRM) is a high-throughput MR microscope that utilizes an array of gradient probes [1,2]. The key technology in the SPMRM is how many gradient probes can be packed in the restricted homogeneous region of the magnet. In the present study, we developed a design rule for the probe array and constructed a linear array probe for human embryo samples.

Design Rule for Gradient Probe Array

The gradient probes for the SPMRM consist of planar gradient coil sets and shielded RF coils. Figure 1 shows gradient probe arrays packed in the homogeneous region of a magnet: the dotted circles show the homogeneous regions and the squares show the probe units. Circles on the probes show sample areas. From a geometrical consideration, the number of the probes N can be expressed as

$$N = n\sqrt{D^2 - (n-1)^2 W^2}\,/\,d\,,$$

where $D = D^* - a$ (D^*: diameter of the homogeneous region, a: sample diameter), n is the number of the row of the array, and W and d are the width and thickness of the probe. For a given D, N can be maximized with the probe size and n.

8 Channel Linear Probe Array for Human Embryo Samples

To construct an 8-channel array probe for $D^* = 160mm$ and $a = 8mm$, two array designs ($n = 1,2$) were compared. As a result we selected $n = 1$ (Fig.2), because the probe thickness d was optimized first of all, and could be made less than 18 mm by using a 3 mm-thick 3-axis planar gradient coil set. Figure 3 shows median sagittal sections selected from 3D image datasets of Carnegie stage 16 chemically fixed human embryos (Kyoto collection) acquired with this probe and a T_1W-3DSE sequence at 100 MHz. Although this array probe are now routinely used with an 8-channel parallel MRI transceiver system, if we use $n = 2$, $d = 18mm$, and $W < 85mm$, a 14-channel probe array can be constructed for our 40 cm RT-bore superconducting magnet. In conclusion, the design rule developed in this study gives a useful guide to construction of a probe array for the super-parallel MR microscope.

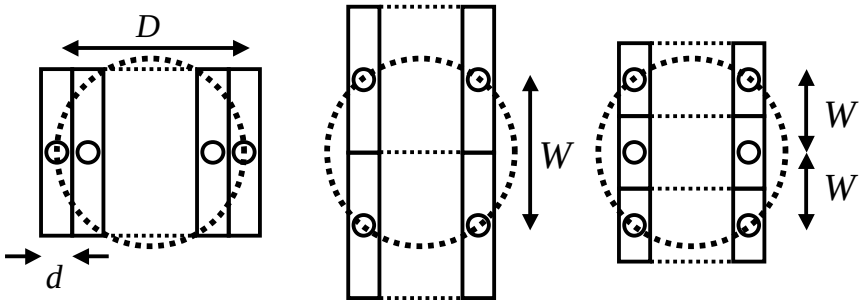

Fig.1 Geometry of the gradient array probe. Left: n=1, center: n=2, right: n=3.

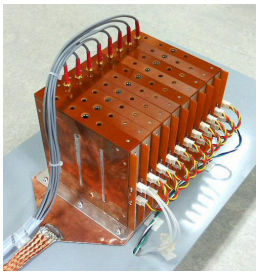

Fig.2 8CH linear array probe

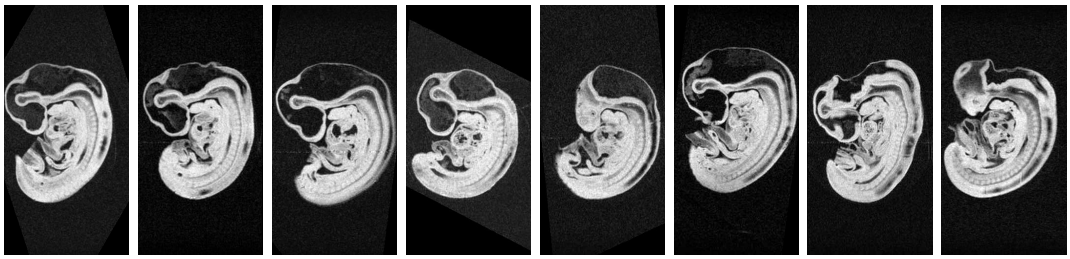

Fig.3 2D sections selected from 3D image datasets of CS 16 human embryos ((55μm)^3 voxel).

References

[1] Kose K, et al, Proc of 9th ISMRM, 2001, p609. [2] Matsuda Y, et al, Magn Res Med 50 (2003) 183-189.