3D MR microscopy of the human embryo collection (Kyoto Collection): final report for 1,200 human embryos

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Abstract

The Kyoto Human embryo MR microscopy project was started in May of 2003, and completed in November of 2004. In this project, 3D MR microscopic images of about 1,200 embryos were acquired at the spatial resolution of 40 to 150 microns cubed. This 3D image dataset would be the largest one of human embryos and will be used for studies in human embryology.

Introduction

Kyoto University has a large human embryo collection (~50,000 specimens), which were collected from 1961 to 1974 [1]. Because such a collection will never be obtained again, their nondestructive 3D measurements are highly desired. Kyoto and Tsukuba Universities therefore started a project acquiring 3D MR microscopic images of about 1,000 embryos in May of 2003.

Material and method

Human embryo specimens were chemically fixed in Bouin's fluid and stored in 10% formalin solution [1]. Of the 50,000 preserved embryos, about 1,200 undamaged and normal specimens, ranging from Carnegie stage (CS) 13 to 23, were selected for the project (Table1). Because Tsukuba and Kyoto Universities are about 500 km apart, specimens were transported in NMR sample tubes filled with the formalin to avoid mechanical shock and biological contamination. The embryos were imaged in the same formalin to avoid susceptibility effect, with a four- or eight-channel super-parallel MR microscope [2,3] using a 2.34 T / 40 cm superconducting magnet. All of the embryos (about 100 specimens per each stage) were imaged using a T_1 weighted 3D SE sequence (TR = 100ms and TE = 10ms ~ 16ms)[4].

Result and discussion

Figure 1 shows median sagittal images selected from 3D image datasets of CS 13 to 23 human embryos. The image matrix was 128 x 128 x 256 throughout the stages and the voxel size varied from $(45\mu m)^3$ to $(150\mu m)^3$. The number of signal accumulations was 16 or 24, and the total imaging time was about 8 or 12 hours (Table1). The human development process is clearly visualized.

Conclusion

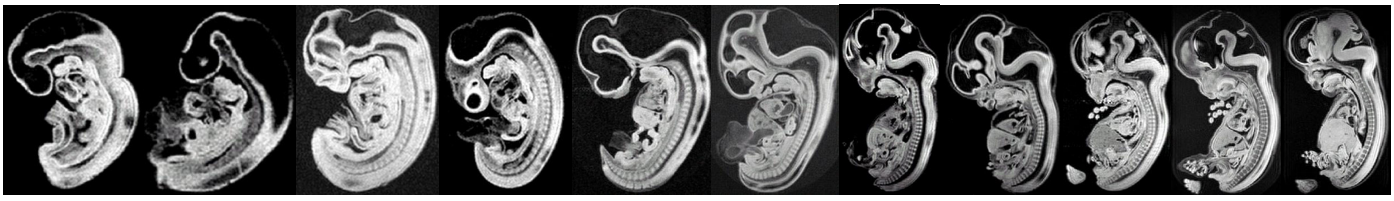
We completed all of the human embryo measurements in November of 2004. As far as we know, this MR microscopy dataset is largest one of human embryos [5] and will be useful for studies in human embryology.

References

[1] Nishimura H, Takano K, Tanimura T, Yasuda M. Teratology, 1 (1968) 281-290.
[2] Kose K, Haishi T, Matsuda Y, Anno I, Proc of 9th ISMRM, Glasgow, 2001, p.609.
[3] Matsuda Y, et al, Magn Res Med 50, 183-189 (2003).
[4] Matsuda Y, et al, Proc of 12th ISMRM, Kyoto, 2004, p.61.
[5] Smith BR, Scientific American, 280:76-81, March 1999.

CS	Number of samples	Crown-rump length (mm)[1]	Sample tube ID (mm)	Voxel Size $(\mu m)^3$	NEX
13	27	4.0	4/7	40~50	16/24
14	120	7.0	7	40~55	16/24
15	120	8.0	7/9	45~60	16/24
16	133	8.5	7/9	50~60	16
17	128	10	7/9	70	16
18	129	11	9	80	16
19	149	15	11	100	16
20	149	16	11	100	16
21	132	20	13.5	120	16
22	62	23	13.5/18	120/150	16
23	52	30	13.5/18	120/150	16

Table1 Human embryos imaged in this project



13(50) 14(50) 15(55) 16(60) 17(70) 18(80) 19(100) 20(100) 21(120) 22(120) 23(120)

Fig.1 Median Sagital image of human embryos (CS 13 to 23). Numbers in the parentheses are length of the sides of cubic voxel.