Volumetric assessment of fetal organ development using whole-body 3D-true-FISP
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Introduction
Volumetric assessment is one of the important methods to assess the fetal development. Previously this had been done using ultrasonography or 2D MRI [1-3]. However, fetal abnormalities sometimes occur at multiple organs, and we thought whole body fetal imaging can be of value.

The purpose of this study was to assess the volumetric changes of the fetal organs along with development using whole-body 3D-FISP imaging.

Subjects and Methods
The ethical review board approved this study. MRI was performed on a 1.5T unit (Avanto, Siemens). Seven fetal whole-body images (gestational age at MRI, 20-37 weeks) of four normal fetuses (volunteer) and the two fetuses suspected for a minor abnormality at ultrasonography (bowel dilatation (n=1), small cyst in the lung (n=1)). The fetal whole-body 3D-true-FISP was performed under pregnant woman's breath-holding with the scanning parameters as follows: TR/TE, 3.53/1.56 msec; flip angle, 45-50 degrees; matrix, 256×256; slice thickness, 3 mm with interpolation to 1.5 mm; field of view, 380 mm. The images were transferred to a workstation, where segmentation of the fetal organs was performed using a semi-automated and manually-corrected method using an in-house program. Volumes of the segmented organs included the brain, lung, heart, liver, and kidneys were calculated. The relation between the measured volume of each organ and the gestational weeks at MRI were assessed using Pearson's correlation coefficient.

Results
The measured volume of each organ ranged from 41.1 to 281.9 cm³ at the brain, from 23.4 to 100.5 cm³ at the lung, from 1.9 to 34.2 cm³ at the heart, from 13.0 to 105.0 cm³ at the liver, and from 2.0 to 15.0 cm³ at the kidneys, respectively. There were positive correlations between the fetal organ volumes and the gestational week at the brain (p<0.001, R=0.97), the lung (p=0.006, R=0.90), the heart (p=0.018, R=0.84), the liver (p<0.001, R=0.97) and the kidneys (p<0.001, R=0.96).

Discussion and Conclusions
The volumes of the fetal organs linearly increased as the increment of the gestational age at MRI in this study. Therefore whole-body fetal imaging with 3D-true-FISP can be a reproducible method for the assessment of the fetal development. Although we set shorter acquisition of MR imaging, this is not free from fetal motion. Furthermore, lower imaging contrast compared to spin-echo sequence was disadvantage for assessment of the small tissue.

Whole-body 3D-true-FISP imaging may reflect the volumetric development of the fetal organs along with the gestational age.

References