

Three-dimensional cine phase contrast image can replace two-dimensional cine phase contrast MR imaging for the assessments of pulmonary artery velocities and their related parameters.

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PURPOSE

Pulmonary artery flow velocities, flow volume and their derived parameters, such as acceleration time (AT), acceleration volumes (AV) and maximum flow (MF) vary depending on the degree of pulmonary diseases such as pulmonary hypertension (1). Therefore, accurate and consistent measurements of pulmonary artery velocities are very important for the assessment of pulmonary diseases. Unlike two-dimensional (2D) cine PC MR imaging, three-dimensional cine phase contrast MR imaging (4D-Flow) enables retrospective selections of arbitrary sections of the pulmonary arteries. 4D-Flow is therefore a powerful tool to avoid “imaging-plane-selection-based-failure” in velocity measurements within the pulmonary artery. The purpose of our study was to compare pulmonary artery flow parameters between 4D-Flow and conventional 2D cine PC MR imaging.

METHOD AND MATERIALS

The study employed four normal volunteers (median age of 25 years) and five patients with pulmonary diseases (median age of 75 years). 2D and 3D cine PC MRI was performed using a 3.0T MR Imager (Signa HDx, GEHCJ). Pulmonary arterial boundary was segmented based on the intensities of both magnitude images and phase images obtained by 4D-Flow. Blood flow velocities were measured at the identical cross-sections at the pulmonary arteries to that imaged on 2D. For imaging plane selections; we created streamline images with Flova2 software (R'tech, Japan) and avoided vortex flow within the pulmonary arteries (Fig.1). We then calculated and compared the flow parameters including AT, AV and MF based on the pulmonary arterial velocities obtained by both 2D and 4D-Flow. We used Spearman's rank-correlation coefficient test and Bland-Altman plot for the statistical analysis. 4D-Flow protocol (Respiratory compensated ECG gated GRE-based cine PC image with parameters of TR(ms)/TE(ms)/FA(degree) of 5.6/2.8/9, matrix of 256x224, section th(mm)of 2, cardiac phase of 20 was performed at VENC (cm/s) of 150 with imaging time of 8.2 min.)

RESULTS

The r values of Spearman's rank-correlation coefficient test in comparison between 4D-Flow and 2D cine PC MR imaging were 0.63, 0.95 and 0.97 for AT, AV and MF respectively (Fig2). Results of AT, AV and MF obtained from 4D-Flow were quite close to those from 2D cine PC MR imaging using Bland-Altman method (Fig3).

DISCUSSION

This study showed good correlations of pulmonary arterial blood flow parameters including AT, AV and MF between 4D-Flow and 2D cine PC MR imaging. The beauty of 4D-Flow is that it allows retrospective settings of arbitrary sections of the pulmonary artery observing the streamlines, thereby; avoiding the vortex flow and other abnormal flow that may cause unwanted bias in measuring the consistent pulmonary flow assessments.

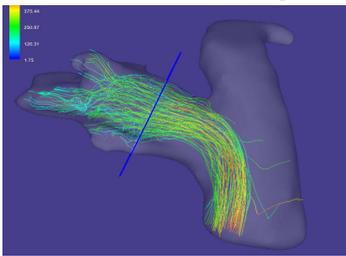


Fig1. Pulmonary arteries using 3D cine PC

CONCLUSION

Hemodynamic analysis with the aid of 3D cine PC MR imaging is promising for the evaluation of pulmonary diseases.

CLINICAL RELEVANCE/APPLICATION

Good agreements are present between 3D and 2D cine PC MR imaging for evaluation of pulmonary arterial flow biomarkers. We can replace 2D cine PC MR imaging with 3D cine imaging.

REFERENCE

- Sanz J, et al. Pulmonary arterial hypertension: noninvasive detection with phase-contrast MR imaging. *Radiology*. 2007 Apr;243(1):70-9.

MR streamline imaging

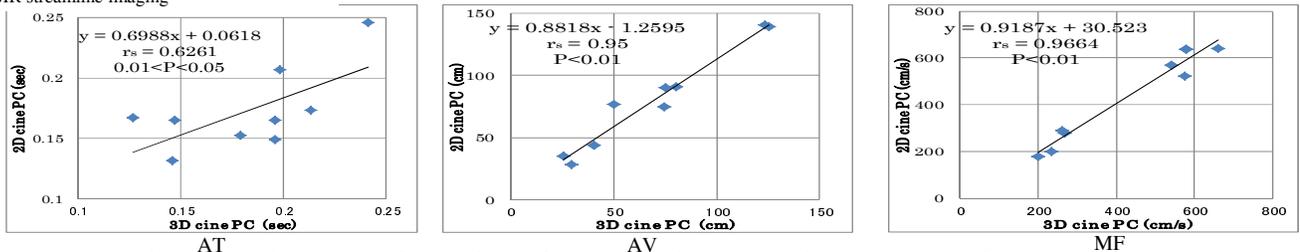


Fig2. Spearman's rank-correlation Plot Graph of Acceleration Time , Acceleration Volume and Maximum Flow

