Flow-Motion FBI, a novel non-contrast-enhanced 3D-MRDSA technique using ECG-Triggered Three-Dimensional Half-Fourier FSE -the feasibility to evaluate hemodynamics of peripheral vascular diseases-

K. Nakamura[1], A. Yamamoto[1], K. Kuroki[1], M. Miyazaki[2], Y. Matsufuji[3]

[1]Radiology, Tobata Kyoritsu Hospital, Kitakyushu, Fukuoka, Japan, [2]Toshiba America Medical Systems, Rolling Meadows, IL, United States, [3]Toshiba Medical Systems, Fukuoka, Fukuoka, Japan

INTRODUCTION

Non-enhanced flow-spoiled fresh blood imaging (FBI) using ECG-triggered 3D half-Fourier FSE, which employs a signal difference of pulsatile flow between diastole and systole, has been reported to obtain 3D arterial images in high resolution [1]. However, it provides mainly morphological information. A non-contrast-enhanced MRDSA technique, continuous acquisitions of multiple phases using ECG-triggered 2D half-Fourier FSE, has been reported to obtain vascular information of peripheral and cerebral hemodynamics without administration of contrast agent [2, 3]. This allows observation of vascular hemodynamics of peripheral vascular occlusion with collaterals and arteriovenous malformation (AVM). However, it has a limit of signal-to-noise ratio (SNR) and spatial resolution in the slice direction because of a thick slice 2D projection acquisition. Therefore, overlapped vessels in the slice direction were difficult to separate and anatomy of small vessels was not evaluated in detail. In this study, we extended the 2D MRDSA to 3D MRDSA (flow-motion FBI) acquisition in order to have a higher SNR to examine detailed vascular anatomy and better resolution in the slice direction to monitor hemodyamic information.

MATERIALS AND METHODS

Basic concept of flow-motion FBI is as same as that of 2D non-contrast enhanced MRDSA, which is a downstream pulse wave transmits from proximal to distal arteries after a cardiac ejection. Using a short echo-train-space (ETS) half-Fourier FSE, arteries are depicted in low signal intensity during early systole, which is because fast arterial flow during systole has more dephasing effects. Therefore, if the arterial signal were observed using a short ECG interval during the phase of a pulse wave transmission, low signal or flow-void signal would transmit within vessels from the proximal to the distal region (Fig. 1).

All MR examinations were performed using a 1.5-T clinical imager (EXCELART, Toshiba, Japan), using a QD torso SPEEDER coil. All data were acquired in coronal plane using ECG- or peripheral pulse gating (PPG)-triggered 3D half-Fourier FSE with partial flow-compensation and parallel imaging. Acquisition parameters are 1 shot, TR of 3 or 4 R-R intervals, ETS of 5 msec, TEeff of 30 msec, matrix of 224x256, a 4-7 mm thick slice, a parallel imaging factor of 2.5, and FOV of 37x37 cm. Multiple cardiac phases were acquired with a 10-msec increment delay starting from a 30-msec delay of an R wave, and a total of 10-20 phases was obtained in 3D images in order to observe the detailed transformation of arterial signal changes. A total acquisition time was about 15-30 minutes. After acquisitions, dynamic subtractions from diastolic images provide 3D MRDSA-like images, and thus permit observation of natural hemodynamic flow.

Four healthy volunteers and 3 patients with arteriosclerosis obliterans (ASO) were evaluated to study the feasibility of flow-motion FBI to observe flow dynamics information.

RESULTS and DISCUSSION

Five to 10-msec increment delay time enables to demonstrate flow void area, which transmits from proximal to distal region even in 3D images, and could provide DSA-like hemodynamic information in 3D images. Using a long increment delay time, a total scan time was shorter since less cardiac phases were required; however, temporal resolution of hemodynamics was not enough to observe in detail. Figure 2 shows flow-motion FBI of an ASO patient with an obstruction at the left common iliac artery and well-developed collateral arteries. Volume rendering images demonstrate hemodynamics via collateral arteries, which is from the lumber artery to an artery in pelvic wall, internal iliac artery (opposed direction), then external iliac artery. Multidirectional observation is possible in 3D images, which provides more precise evaluation of complicated connections of collaterals. Flow-motion FBI provides clinically useful DSA-like information; however, it takes a long time to acquire many phases of 3D data, which may cause artifacts by mismatch in the subtraction method. Considerable artifacts were observed at the point of drastic signal changes during early systole in some cases.

CONCLUSION

Flow-motion FBI provides 3D MRDSA-like images and permits observation of natural hemodynamic flow without contrast materials.

REFERENCES

1] Miyazaki M, Takai H, et al. Radiology 227:890-896, 2003.
2] Nakamura K, Yamamoto A, et al. ISMRM p1356, 2003.
3] Nakamura K, Yamamoto A, et al. ISMRM, p2571, 2004.

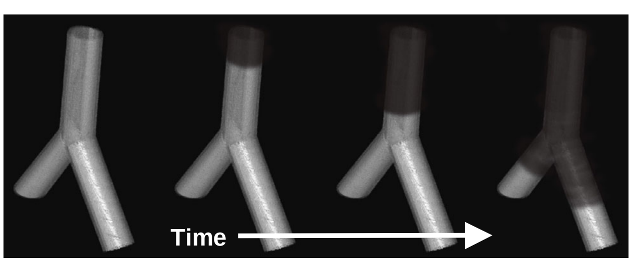

Fig1. 3D illustration of flow void transmission (dark area)

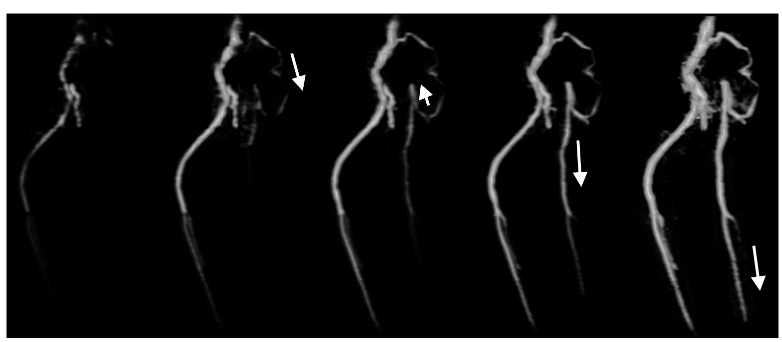

Fig2. Flow-motion FBI of pelvic region demonstrates obstruction of left common iliac artery with flow via well developed collaterals. (VR image, left anterior oblique projection)