Feasibility of quantitative analysis of non-contrast-enhanced MRDSA using ECG-gated two-dimensional half-Fourier FSE for the assessment of peripheral vascular diseases

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

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

Purpose

A novel 2D non-contrast-enhanced MR digital subtraction angiography (MRDSA) technique using ECG-gated 2D half-Fourier FSE is reported, which employs a flow void phenomenon of pulsatile flow and provides DSA-like images [1]. The feasibility of the technique was studied for evaluating hemodynamics of peripheral, cervical, and cerebral arteries [2,3]. However, only qualitative evaluation was performed to evaluate an appearance of arteries. The purpose of this study is to assess quantitative analysis of non-contrast enhanced MRDSA on peripheral arterial diseases and which was then compared with the grade of stenosis and ankle-brachial index (ABI) for clinical usefulness of peripheral blood flow.

Materials and Methods;

Institutional review board approval and informed consent were obtained for all patients. Eighteen consecutive patients, 15 males and 3 females with a mean age of 73.5 years (range 40-90 years), with suspected peripheral arterial diseases were evaluated.

All MR examinations were performed using a 1.5-T clinical imager (EXCELART, Toshiba, Tokyo) with an 8-ch torso SPEEDER coil. Two-dimensional (2D) single-shot thick slice images in multiple cardiac phases were acquired in the coronal plane with ECG-triggered half-Fourier FSE, TR of 3 or 4 R-R intervals, ETS of 4 msec, TEeff of 32 msec, matrix of 192x256, a 70-mm thick slice, and FOV of 37 cm. Multiple cardiac phases were acquired using a 10-msec interval between the images starting zero delay from the R wave, and a total of 30-40 phases were acquired. The diastolic images depicted arteries in bright blood signal were subtracted from the following systolic images, resulting in obtaining the images demonstrating hemodynamic flow. Fresh blood imaging (FBI) was also underwent simultaneously, with using ECG-triggered three-dimensional (3D) half-Fourier FSE, which provided non-contrast enhanced 3D arteriogram for grading of stenosis using 3-point scale (grade 1, <49% luminal narrowing; grade 2, 50%-99% luminal narrowing; grade 3, occlusion).

Signal changes were measured on each leg using ROI analysis, which was placed distal to stenosis or occlusion, from the time of a trigger R wave to the starting point of signal decrease (SPD) at the systolic phase. ABI was calculated by the ratio of the ankle systolic pressure divided by the arm systolic pressure using ABI-form (Colin, Japan).

Results;

Figure 1 shows the average SPD according to the grade of stenosis. The SPD of the grade 2 stenosis (50-99%) was significantly longer than that with grade 1 (<50%) (110±15 msec, 75±14 msec, respectively; $p<0.01$). The SPD of the grade 3 (occlusion) was significantly longer (170±21 msec) than that with grade 2 ($p<0.01$), or that with grade 1 ($p<0.01$). There was an inverse correlation between SPD and ABI; correlation coefficient was -0.72.

Figure 3a shows a 3D flow-spoiled FBI image of an ASO patient with an occlusion at the left external iliac artery. Figure 3b) shows non-contrast-enhanced MRDSA, demonstrating that the appearance of the artery distal to the occlusion is delayed compared to the right normal side, which may be owing to the decreased arterial pressure distal to the occlusion.

Discussion;

The delay in starting time of arterial signal decrease (SPD) according to the high grade of stenosis and lower ABI was thought that pulse wave transmission was delayed because of decreased pressure owing to occlusion or severe stenosis. Our study suggests possibility of evaluating peripheral arterial diseases more precisely using the quantitative analysis in addition to qualitative analysis by optical evaluation of vascular demonstration. Combination of nonenhanced 3D images obtained using flow-spoiled FBI and non-contrast-enhanced MRDSA allows not only studying morphology of the vessels but flow dynamic information, especially in patients with arterial diseases without contrast materials.

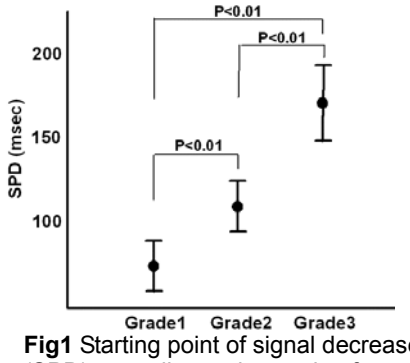

Fig1 Starting point of signal decrease (SPD) according to the grade of stenosis

Fig2 72 y.o. male with rest pain of left leg. Flow-Spoiled FBI shows occlusion of left external iliac artery (black arrow, Fig2a). Non-contrast enhanced MRDSA demonstrates delayed appearance of the arteries distal to the occlusion compared with the opposite side (white arrow, Fig2b). Right: SPD=70msec, ABI=1.07 Left; SPD=180msec, ABI=0.45

REFERENCES

1] Nakamura K, Yamamoto A, et al. ISMRM p1356, 2003.

2] Miyazaki M, Yamamoto A, et al. ISMRM, 2003

3] Nakamura K, Yamamoto A, et al. ISMRM, p2571, 2004.