Investigation of an aerobic exercise effect on the peripheral blood flow in the visualization of nonenhanced Fresh Blood Imaging (FBI)

R. Nagashima[1], K. Nakamura[1], A. Yamamoto[1], K. Kuroki[1], and M. Miyazaki[2]

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

PURPOSE

Fresh blood imaging (FBI) is a nonenhanced MR angiography technique, employing an arterial signal difference between systole and diastole during a cardiac cycle [1]. Larger signal difference between two phases allows better conspicuous arterial demonstration. Cardiac output and peripheral blood flow increase physiologically after an exercise, which may therefore affect vascular demonstration FBI. The purpose of this study is to investigate the effect of aerobic exercise in the visualization of peripheral arteries of FBI.

Material and Method

Institutional review board approval and informed consent were obtained. Five normal healthy volunteers performed a 20-minutes exercise using bicycle ergometer at heart rates of about 100 – 120 bpm. The pelvic and femoral regions were examined at the following five phases; phase 1; pre-exercise, phase 2; just after exercise, phase 3; 30 minutes after, phase 4; 1 hours after, phase 5; 2 hours after.

All MR examinations were performed using a 1.5-T clinical imager (EXCELART, Toshiba, Tokyo) using a torso SPEEDER coil. Three-dimensional (3D) half-Fourier FSE acquisition parameters were as follows: TR=3 RR intervals, TEeff =80 msec, TI=190 msec, ETS= 5 msec, matrix=256 x 256, section thickness of 4 mm (interpolated to 2 mm), field of view of 37 x 37 cm, and a total acquisition time of 2-3 minutes. Both diastolic and systolic ECG-triggered 3D data were acquired, the systolic images were subtracted from the diastolic images, and the subtracted images then underwent a maximum intensity projection (MIP) processing.

Four observers evaluated the visualization of large arteries and small peripheral branches in all 5 phases with a 4-point grading system (4; arteries were clearly visualized, 3; arteries were almost clearly visualized, 2; arteries were partly not visualized, 1; arteries were almost not visualized). The change in signal-to-noise ratio (SNR) of superficial femoral artery was also measured using an ROI analysis.

Results and discussion

Visualization of arteries:

The SNRs of large arteries in the phase 2, 3, and 4 were significantly higher than that of the phase 1 (pre-exercise), resulting in better depiction in the optical evaluation (Fig1). In the phase 5 (2-hour after), the SNR of large arteries reduces similar to the phase 1 level. In two subjects, the visualization of large arteries at the phase 2 becomes less than that of phase 1, because N/2 artifacts appear from those arteries in the systolic-triggered images, due to the increased flow velocity of arteries. In the phase 2, 3, and 4, the demonstration of small peripheral branches was significantly improved as compared to that of the phase 1. After exercise, the increased flow during systole allows larger dephasing or better flow-voids of arterial signals, meaning a larger signal difference between systolic and diastolic images, resulting in better conspicuous arterial depiction.

Background signals:

The background signals tend to increase after the exercise. Among 3 in 4 subjects, N/2 artifacts of the femoral veins were demonstrated even at the phase 4 (2-hour after) (Fig2). Although arterial visualization becomes almost equal to the phase 1, pre-exercise level, venous flow still increases.

Conclusion

Moderate-intensity exercise makes the peripheral blood flow increase, making the marked improvement in visualization of arteries in FBI; however, the background signals are also significantly increased in the examination just after 1-hour. Regarding the continuance of the effect of cycling exercise, the arterial visualization improved for at least 1 hour after the exercise; however, the N/2 artifacts of femoral veins become noticeable. The increase in peripheral blood flow is possibly maintained at the phase of 2-hour after the exercise.

References

[1] Miyazaki M, Takai H, et al. Radiology 227:890-896, 2003

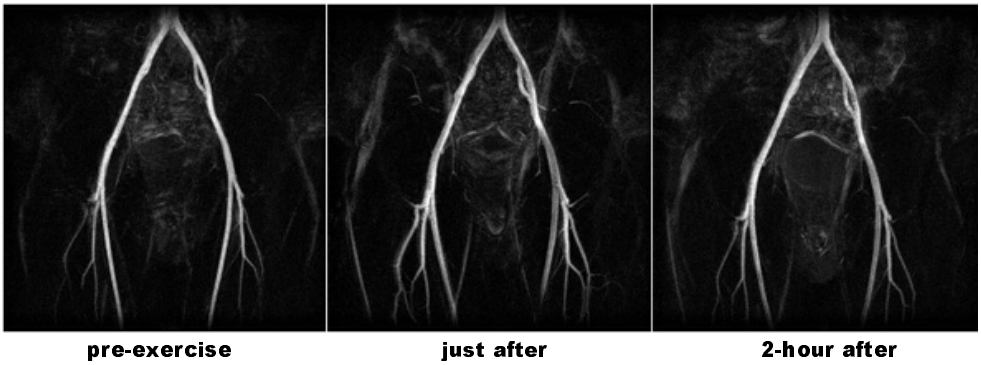

Fig 1 FBI of pelvic region in pre- and post-exercise

Fig 2 N/2 artifact of com and ext. iliac vein at 2-hour after the exercise (arrow)