Evaluation of Muscle Blood Flow of the lower-leg After Exercise using 3D-pCASL Volume Data

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PURPOSE:

To comprehend the clinical physiology of the skeletal muscle disease, direct assessment of the muscle blood flow is essential. However, muscle blood flow (MBF) is the low baseline flow, and which tends to be maintained even in disease states. Thus MBF measurement should test under stress [1]. The objective of our study is to evaluate how much change in the MBF of each lower-leg muscle at the long axis before and after exercise using three-dimensional (3D) pulsed-continuous arterial spin labeling (pCASL) MRI.

METHODS:

On a 3.0-T MRI, we obtained transverse MBF images of the lower-leg using 3D-pCASL before and after plantar flexion exercise at one time per second for one minute in healthy volunteers (n=12). The 3D-pCASL with fast spin-echo spiral scan was used with parameters of 1450 ms labeling duration, 512 point (5 arms), and 2025 ms post labeling delay. We then determined the blood flow of tibialis anterior (TA), gastrocnemius medialis (GM), gastrocnemius lateralis (GL), and soleus muscle (SL). Moreover, we also determined the mean total blood flow (anterior and posterior tibial artery, and fibular artery) during the cardiac cycle obtained with ECG-gated phase contrast cine-MRI (PC cine-MRI) before and after the same plantar flexion exercise, and compared with the MBF values. PC cine-MRI was implemented with 13/5.0 ms TR/TE, 80 cm/s VEMC, 32 cardiac phases.

RESULTS:

No significant difference was found between the MBF in each muscle and the longitudinal portion at rest, but MBF in all muscles after exercise was significantly higher than those before exercise (Fig. 1 and 2). MBF of TA, GM, GL, and SL increased by 166.1, 30.7, 57.3 and 18.5% after the exercise, respectively, but no significant difference was found between MBF at the longitudinal portion in each muscle after the exercise. There was a positive correlation between change in the MBF in all muscles and change in the total blood flow obtained with PC cine-MRI after exercise (Fig. 3).

CONCLUSION:

3D-pCASL makes it possible to obtain volume blood flow data of the lower-leg muscle and evaluate change in regional blood flow of the lower-leg muscle after exercise.

REFERENCES:

[1] Wu WC et al., J Magn Reson Imaging 2008: 28: 445-452.

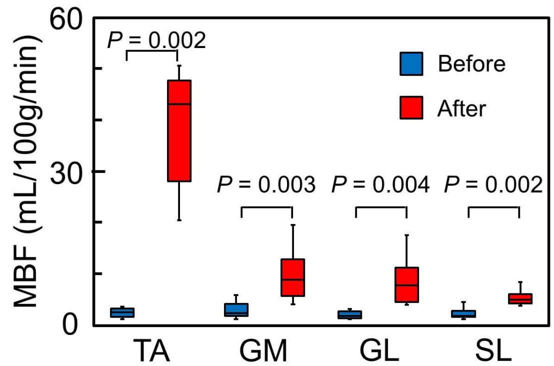

Fig. 1 pCASL-derived MBF before and after exercise.

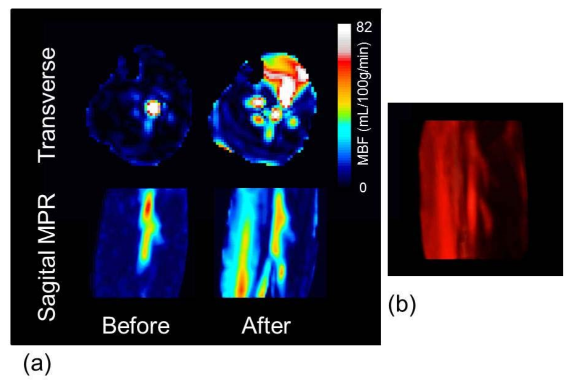

Fig. 2 An example of (a) MBF images of the calf muscle before and after exercise, and (b) MBF volume rendering after exercise.

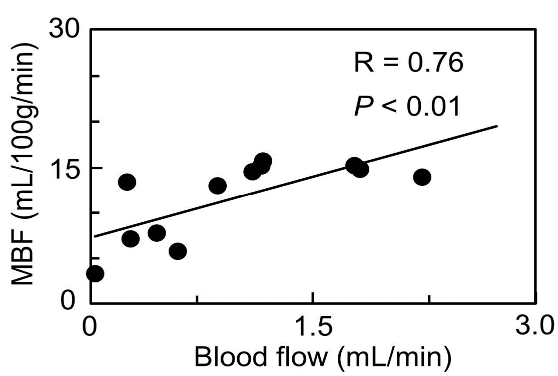

Fig. 3 Relation between pCASL-derived MBF change of all muscles and total blood flow change obtained with PC cine-MRI after exercise.