Muscle Post-Contractile BOLD Transients decrease with age, inactivity, and BMI, but not with Type 1 Diabetes.

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Introduction

Recent studies show that single, brief, voluntary contractions of peripheral skeletal muscles are followed by transient hyperemia which can be detected as a transient increase in signal intensity (SI) in T2-weighted MR images (1,2). The post-contractile MRI transients are similar to transient increases in muscle PO_2 measured by near-infrared spectroscopy of hemoglobin, suggesting that they arise primarily from a blood-oxygenation (BOLD) effect. Interestingly, the magnitude of the MRI measured post-contractile transients was reported to vary widely between individuals, even within a population of healthy young adult subjects, suggesting that the measurement might provide a non-invasive method to access microvascular density and/or reactivity in skeletal muscle (1). Microvascular density decreases with chronic physical inactivity, and microvascular reactivity may decrease in with aging, and in patients with diabetes mellitus (3). The primary purpose of this study was to compare the magnitude of muscle post-contractile BOLD transients in otherwise healthy Type 1 diabetic patients vs. matched control subjects. In addition, the study enabled examination of the effects of chronic physical activity and age on the BOLD transient magnitude.

Methods

Type 1 diabetes patients (n=15) were recruited from local clinics, and individually matched control subjects (n=15) were selected from a pool of volunteers recruited from the community. The study was approved the University and Clinic IRB's, and subjects gave informed, written consent. Subjects were matched with respect to age (diabetic 33±3 vs. control 33±3 yr, mean±SE), sex (5 females/group), body mass index (BMI, 25.5±0.8 vs. 25.6±0.9 kg/m^2), and activity level as assessed by a standard instrument (ref 4, score 34.8±0.7 vs. 34.2±0.5). Axial, one-shot echo-planar images (64x64 matrix, 1 cm slice, 18 cm field-of-view, TR/TE=1000/40) were continuously acquired while the subjects performed seven one-second duration, maximal isometric ankle dorsiflexion contractions at 30 intervals (240 images/slice). SI of the anterior compartment muscle was measured in a 4-7 cm^2 region-of-interest drawn by a blinded observer. The time course of SI changes after the last 5 contractions was averaged, and the peak transient magnitude (% change in SI from baseline) and time-to-peak magnitude (s) were measured by the blinded observer.

Results

As expected from the previous study, the post-contractile transients varied dramatically between individuals (FIG. 1). However, there was no significant difference in mean responses between diabetic vs. matched control subjects (TABLE). Pooling the data from all 30 subjects, there were significant negative correlations between transient magnitude vs. BMI (multiple correlation, r=-0.504, p<0.005, FIG 2) and age (r=-0.462, p<0.01) and positive correlation vs. activity level (r=0.403, p<0.027).

TABLE	Controls	Diabetics
Δ SI (%)	2.09±0.49	2.04±0.38
Time Peak (s)	9.4±.0.3	9.9±0.6
Hb1Ac (%) (n=)	5.13±0.13 (9)	7.81±0.33* (13) *p<0.05

Discussion

The results show that post-contractile BOLD transients are not systematically altered in peripheral muscle of otherwise-healthy Type 1 diabetic patients compared to matched control subjects. However, the results indicate that the transient magnitude decreases with physical inactivity, increased BMI, and age, suggesting it can provide an index of peripheral vascular conditioning.

References.

1) Meyer, R.A., et al, NMR Biomed. 17:392, 2004.
2) Hennig, J., et al, Proc. Intl. Soc. Magn. Reson. Med. 8:122, 2000.
3) Baron, A.D. Am. J. Cardiol. 84: 25J, 1999.
4) Sallis, J.F., Am. J. Epid. 121:91, 1985.

FIG. 1

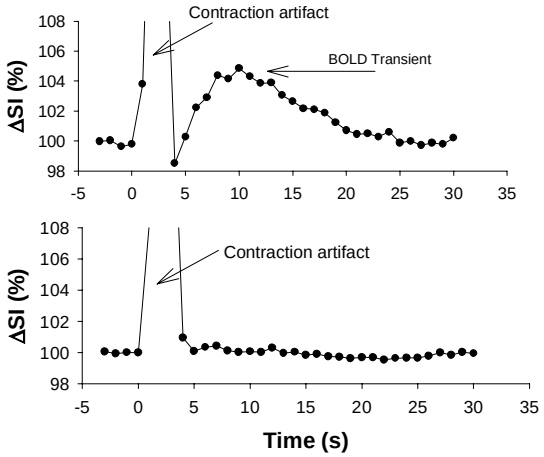

FIG. 2