

# Exercise-induced muscle activities of the trunk: detectability of the slight impact using muscle functional MRI

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## Introduction

Exercise-induced muscle activity is essential in sports medicine and rehabilitation medicine, especially for the trunk muscle. Magnetic resonance imaging (MRI) can evaluate muscle activity; transverse relaxation time (T2) of exercised muscle increases compared to that of rested muscle [1]. Previous studies have proposed the muscle functional magnetic resonance imaging (mfMRI) [2, 3], which visualizes muscle activity in enhanced activated muscle. However, to calculate T2, the mfMRI using a spin echo (SE) sequence, which requires an acquisition time lasting several minutes. Furthermore, the body parts that can be studied by mfMRI are limited to the limbs. However, the evaluation of strength training-induced muscle activity also requires examination of the trunk muscle, which has a limitation of scan time. Therefore, the mfMRI needs marked improvement of the time resolution for calculating muscle T2. In order to evaluate trunk muscle activity induced by exercise, we proposed and verified the feasibility of mfMRI using ultrafast imaging (fast-acquired mfMRI: fast-mfMRI or functional T2 mapping) [4]. This study evaluated the detectability of the slight impact on trunk muscle activity induced by acute exercises.

## Methods

The right psoas major muscles of seven male subjects (24.7±3.2 years, 171.2±9.8 cm, and 63.8±11.9 kg) at rest and after exercise were scanned using a 1.5T whole body scanner (Magnetom Symphony; SIEMENS) with a body-array coil. Two protocols were employed (a) true fast imaging with steady precession (TrueFISP) with TR 4.72 ms, TE 2.36 ms, matrix size 256×256, FA 50, BW 501 Hz/Px, acquisition time 12 seconds. (b) spin-echo echo planar imaging (SE-EPI) with TR 2000 ms, TE 30, 45, 60, 75 ms (4 echoes), matrix size 128×128 with interpolated into 256×256, FA 90, BW 1392 Hz/Px, acquisition time 2 seconds (for 1 echo). Slice thickness 10mm, FOV 400mm×400mm, NEX 1 were common factors. Subjects performed 15 sets of an exercise while lying supine on the bed (Figure 1). One exercise set, consisted of the subject performing 90-degree hip and knee flexion 20 times. T2 images were calculated using mono-exponential linear least-squares of SE-EPI images. Visualization of muscle activity was made by fast-mfMRI [4]. The cross sectional areas (CSA) and T2 of the right psoas major muscle were extracted from images obtained at rest and after various durations of exercise. Significance of differences between images obtained at rest and after exercise was determined by two-sided paired t-test. Differences with  $P < 0.05$  were considered significant.

## Results and Discussion

Figure 2 shows fusion images (fast-mfMRI) after 1 set, 5 sets, 10 sets and 15 sets. In the fast-mfMRI, the areas of activated right psoas major muscle were well enhanced and morphological details were preserved. Figure 3 shows changes in CSA of after each set, and changes in T2. Although the CSA was increased by exercise, there was no significant difference at rest. For all sets, the changes in T2 were significant compared to those at rest ( $P < 0.01$ ). Moreover, Figure 3 showed that both the CSA and T2 after 7 sets approached a plateau. These results agree substantially with the signal intensity data of the previous study [5]. It was suggested that both the CSA and T2 of exercising muscle rises approximately exponentially to a plateau that depends on exercise intensity.

## Conclusion

In this study, we presented the detectability of trunk muscle activities. Detectability reached a plateau after exercise train. T2 values calculating from SE-EPI images indicated high detectability of slight muscle activities induced by acute exercise.

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Figure 1: The exercise schema flexion exercises of the right thigh repeated 20 times starting from the extended position.

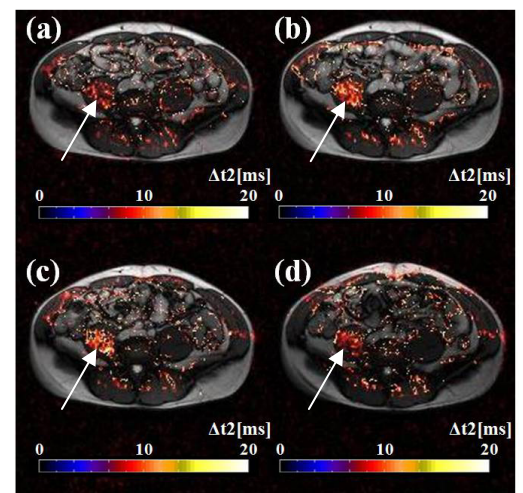


Figure 2: Fused image (fast-mfMRI) obtained after 1 set (a), 5 sets (b), 10 sets (c), 15 sets (d). Color bar shows differences in T2 ( $\Delta T2$ ). Arrows denote the activated right psoas major

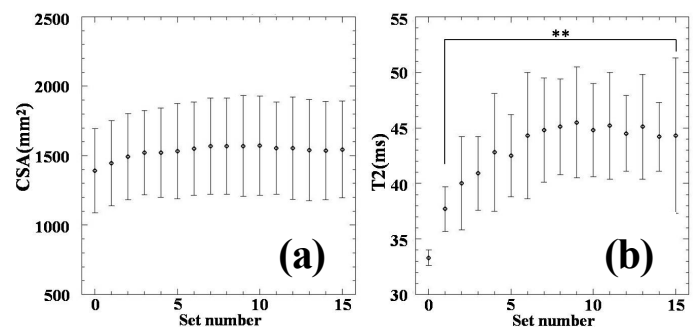


Figure 3: CSA and T2 at rest (set number = 0) and after exercise in seven subjects. (a) CSA. (b) T2. \*\* Significantly different from the value at rest,  $P < 0.01$ .

## References

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