

Effect of ischemia on muscle metabolites assessed with functional magnetic resonance spectroscopy (fMRS) during electrically imposed exercise

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Objectives:

Functional magnetic resonance spectroscopy (fMRS) allows for a well-standardized, non-invasive, continuous monitoring of metabolites involved in energy turnover before, during and after muscle activity imposed by repetitive electrical nerve stimulation. The aim of this study was to assess the effects of ischemia on metabolite depletion and recovery during imposed exercise.

Methods:

6 healthy volunteers were assessed with single voxel (20 x 20 x 40 mm) fMRS (TR 1500 ms, TE 270 ms, 8 averages, repeated with a temporal resolution 12 sec) of the anterior tibial muscle during isometric contraction imposed by peroneal nerve stimulation at 20 Hz during 2 minutes (Fig. 1). Three separate experiments with (A) electrical stimulation without ischemia, (B) stimulation starting after 2 min during a 5 min period of ischemia by proximal blood pressure cuff, and (C) ischemia without stimulation, were performed on each subject. At least an additional 2 min baseline before, and 5 min recovery after (without stimulation or ischemia), was always measured.

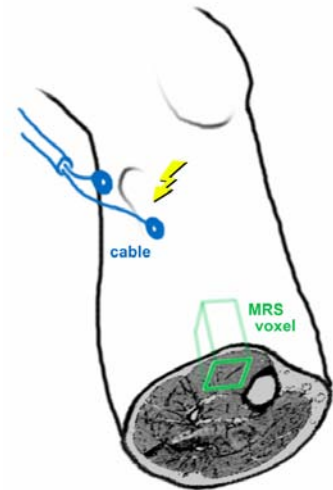
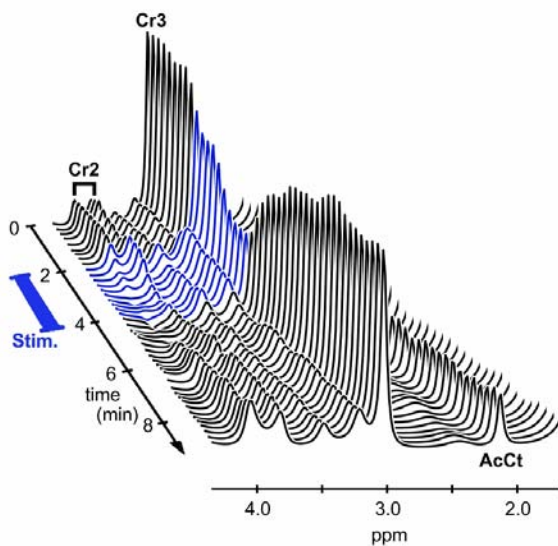


Fig. 1

Fig. 2



Results:

The depletion of the phosphocreatine (CrP) associated peaks (Cr2 and Cr3) and of the acetyl carnitine (AcCt) peak (Fig. 2) during imposed exercise was more complete during ischemia. Furthermore, as long as the ischemia was maintained, these changes persisted even after the stimulator stopped. Only after release of the ischemia, the CrP peaks recovered and the AcCt peak overshoot above baseline, whereas without ischemia, this happened immediately after the contraction stopped.

Conclusion:

Anaerobic pathways are exhausted after short but intense muscle exercise: metabolite recovery is dependent on blood supply, probably especially oxygen supply. Regarding clinical diagnostics of muscle diseases, ischemic muscle due to peripheral arteriopathy must also be expected to yield pathological fMRS responses.

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