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In-magnet bicycling exercise: a novel ³¹P MRS window on the energetics of human locomotion

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ABSTRACT

The clinical standard test of patient fitness is the upright bicycle exercise test. For a number of reasons, no proper equivalent human MR exercise test has been available. Past ³¹P MR studies employing single limb exercise regimens generally failed to put any significant demands on the cardiovascular system (1). As such, a comprehensive understanding of skeletal muscle performance during whole body activity has been lacking. Here, we report on ³¹P MRS studies employing a novel ergometer that for the first time offers true in-magnet human bicycling exercise testing. Heart rates directly following exercise were of 150 ± 15 bpm. In addition to ³¹P MRS study of ATP metabolism over a 100-fold dynamic range of ATP turnover at near-constant pH, it allows for non-invasive ³¹P MRS study of glycogenolysis through the dynamics of hexose monophosphate (HMP) resonances. Here (but not previously (2)) we routinely observed HMP accumulations of up to 10 mM within 2 minutes after termination of exercise at high workloads indicating massive activation of glycogenolysis during the preceding exercise. Yet intramuscular pH typically did not fall below 6.8 during exercise confirming our previous observation of unique homeostatic robustness of quadriceps muscle involved in two-legged exercise (2).

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