MUSCLE ACTIVITY AND [18F]-FLUORO-DEOXY-GLUCOSE UPTAKE IN MUSCLES AND BRAIN DURING SUBMAXIMAL FATIGUING CONTRACTIONS WITH THE ELBOW FLEXOR MUSCLES

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Previous studies found that the time to failure of a sustained submaximal contraction with the elbow flexors was longer when the wrist pushed against a rigid restraint (force task) compared with when the subject exerted the same net muscle torque to maintain limb position (position task). The purpose of this study was to characterize the electromyogram (EMG) activity of elbow flexor and accessory muscles, to quantify [18F]-fluoro-deoxy-glucose ([18F]-FDG) uptake in muscles and brain, and to ascertain the contribution of individual muscles to force and position tasks. Subjects performed both tasks with the left arm and the contraction was sustained at 15% MVC force. The net muscle torque for each subject was identical for the two tasks. The elbow was flexed to 1.57 rad. After determining the time to failure for the position task, each subject performed, in different sessions, the force and position tasks for a duration that was 90% of the time to failure for the position task (973 ± 286 s). The tracer ([18F]-FDG) was injected 180 s after beginning the contraction. EMG activity was recorded in both heads of biceps brachii, brachioradialis, triceps brachii, anterior and posterior deltoid and trapezius muscles using surface electrodes. Immediately after the conclusion of each task, subjects were moved into a positron emission tomography (PET) scanner and static scanning of the upper body was performed to determine contraction-induced [18F]-FDG uptake in muscles and brain during the two tasks. In addition, structural magnetic resonance images (MRI) from the upper body were taken to determine the location of relevant muscles and brain regions. The average EMG activity (%MVC) for all muscles calculated over the entire task was greater during the position task (11 ± 6%) compared with the force task (8 ± 5%, P = 0.03). The surface EMG was positively correlated with [18F]-FDG activity (P = 0.01, r = 0.68). The PET scan measurements showed higher [18F]-FDG uptake in accessory and deep muscles during the position task compared to the force task (e.g., pectoralis major and minor, 11%; rotator cuff muscles, 10%; rectus abdominis, 13%; serratus anterior, 11%; and longissimus thoracis, 27%). The brain [18F]-FDG uptake during the position task was higher in specific brain regions (amygdala, cerebellum, hippocampus, prefrontal cortex) on the right side, underscoring the different neural strategies used during the force and position tasks. These findings indicate that the position task is more difficult than the force task, despite similar net muscle torques, due to a difference in the neural strategy and the quantity of muscle mass activated during the fatiguing contraction. Supported by Ministry of Education of Finland (74/627/2006), Academy of Finland (108539 and 214329), and NINDS (NS43275).

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