REPETITIVE SYMMETRIC ARM TRAINING AND MOTOR CORTEX ACTIVATION IN CHRONIC HEMIPARETIC PATIENTS

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INTRODUCTION

With the development of functional neuroimaging in recent years, several studies have been reported upon cortical reorganization induced by intervention in stroke patients [1,2]. The repetitive bilateral exercises improved functional motor performance of the affected upper extremity of hamiparetic patients [3].

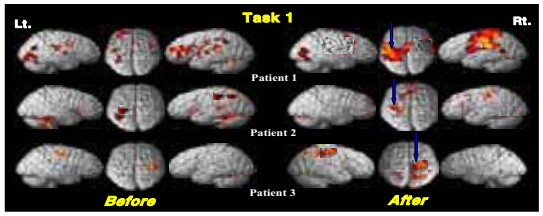
The purpose of this study was to demonstrate the effect of repetitive symmetric arm training, which was designed to improve upper limb function, on functional recovery and upon cortical activation changes in chronic hamiparetic patients using functional magnetic resonance image (fMRI).

METHODS

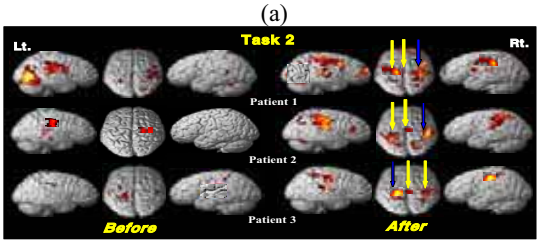
A symmetrical upper limb motion trainer was made of M.C. Nylon suitable for MR environments and designed the affected side can be passively controlled with the same movement according to the active motion of the unaffected side. Totally six subjects participated in this study. As a control group, three of them were right-handed healthy male subjects (age: 34±5 years). In three patients (age: 43.3±6 years), two patients were left hemiparesis and the other was right hemiparesis. All patients received the training at 1hr/day, 5 days/ week during 6 weeks. Fugl-Meyer scores (FMS) were obtained every two weeks during the 6-week training. Before and after the 6-week training program, the blood oxygen level dependent (BOLD) fMRI measurements employing the echo planar imaging (EPI) technique (TR/TE/α=1900/40/90°, FOV=240mm, matrix size= 64×64 and slice thickness=5mm), were performed using a 3T MR scanner (GE Medical System, Milwaukee, USA) with a head coil. A T2-wighted anatomical volumetric images (FSE, TR/TE/α= 4500/104/90°, FOV=240 mm, matrix size=256×256 and slice thickness=5mm) were obtained. During fMRI experiments, two motor tasks were assigned to each subject: Task 1 was an only active wrist extension/flexion on the unaffected and Task 2 was the passive wrist extension/flexion of affected hand by an active wrist movement of unaffected side using the nonferritic device. Significance of the activation between the rest and the task was threshold at $p<0.001$.

RESULTS AND DISCUSSION

In all three patients, FMS of the affected hands improved significantly after the 6-week training program ($p<0.05$). In Task 1, the only dominant wrist movement, in control group, activations in the primary contralateral sensori-motor cortex (SMC) were observed. In Task 2, on the other hand, the passive wrist movement of the non-dominant hand driven by the active wrist movement of the dominant hand, activations in the primary bilateral SMC, supplementary area (SMA) and premotor area (PMA) were observed. In fMRI results in Task 1, a cortical activation in the contralateral (affected) side was observed after the training (Figure 1 (a)). However, Task 2 showed that the contralateral PMA of the unaffected wrist and the bilateral SMA were newly activated and activations in contralateral SMC increased in Patients 1 and 3. However, cortical activations in contralatral SMC of unaffected wrist, bilateral PMA and bilateral SMC were newly activated in Patient 2 (Figure 1 (b)).



(a)



(b)

Figure 1: Cortical activations before and after training during Task 1(a) and Task 2(b) ($p<0.001$), increasingly activated (blue arrow) and newly activated (yellow arrow) areas compared before the training.

CONCLUSIONS

In three patients with chronic hamiparesis after brain injury, specific repetitive symmetric upper limb training appears to improve FMS and induce cortical reorganization. This association supports that developed arm trainer improves arm function by inducing reorganization of motor cortex networks.

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