IS THERE A RELATIONSHIP BETWEEN M1 CORTEX ACTIVATION AND UPPER EXTREMITY MOTOR CHARACTERISTICS DURING ACUTE STAGE AFTER STROKE?

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Objectives

Recovery of upper extremity function after stroke is generally poor. Absolute force and speed of a movement are controlled by the primary motor cortex - M1 (1). This study aimed to establish the relationship between the recovery of M1 and strength and dexterity of hemiparetic upper extremity (HPE) in acute stage after stroke.

Methods and Subjects

Twelve patients with partially impaired function of one upper extremity 2-8 days after first ischemic stroke participated in the study (age: 65 ± 15 years). Measurement of BOLD effect using a single shot EPI was performed on a 1.5 T GE Signa Scanner (General Electric Medical Systems, Milwaukee, WI). FMRI was performed during self-paced upper extremity movement tasks (tumb-to-fingers opposition, transposition of small objects). Prior to fMRI, a 3D anatomical SPGR image was collected. The initial image analysis was performed using FSL. FreeSurfer was used for reconstruction of the individual inflated cortical surface. M1 area was drawn on the individual patients' inflated cortical anatomy using SUMA. Intensity and area of M1 cortex activation were calculated for each brain hemisphere using AFNI. Muscle strength of the HPE was measured with a hand-held dynamometer Chatillon 200, and a hand and pinch grip dynamometers Baseline. Manual dexterity and functional skills were evaluated using Nine Hole Peg Test and timed Action Research Arm Test – ARAT (2). Measurements were performed in the 1st and 3rd week and 3 months after the stroke. Patients participated in the 2 hours functional training according to motor relearning program between the 1st and the 2nd measurement session. Spearman correlation coefficient was used to compare the M1 activation of each brain hemisphere and the motor characteristics of the HPE. Only statistically significant correlation coefficients ($p \leq 0.05$) were presented.

Results

Normalization of brain cortex activation in both hemispheres during tasks performed with the HPE occurred gradually during first 3 months after stroke. Motor characteristics of the HPE improved concomitantly. In the first week after stroke, intensity of ipsilesional M1 activation correlated with muscle strength of shoulder extensors ($r = 0.66$) and abductors ($r = 0.76$), duration of 6 (of 19) ARAT tasks (r = from -0.61 to -0.87; Figure 1a) and Nine hole peg test ($r = -0.70$). In the third week after stroke, there was no correlation between muscle strength and M1 activation. However, 6 ARAT tasks correlated with intensity of ipsilesional M1 activation (r = from -0.59 to -0.80; Figure 1b). Three months after stroke, 9 ARAT tasks correlated with intensity of ipsilesional M1 activation (r = from -0.68 to -0.92; Figure 1c). Area of ipsilesional M1 activation correlated with 3, 1, and 9 tasks of ARAT, during all 3 measurements, respectively (r = from -0.67 to -0.83). Area of contralesional M1 activation correlated with ARAT pinch grip in the week 3 ($r = 0.64$) and with pinch grip strength 3 months after stroke ($r = -0.82$).
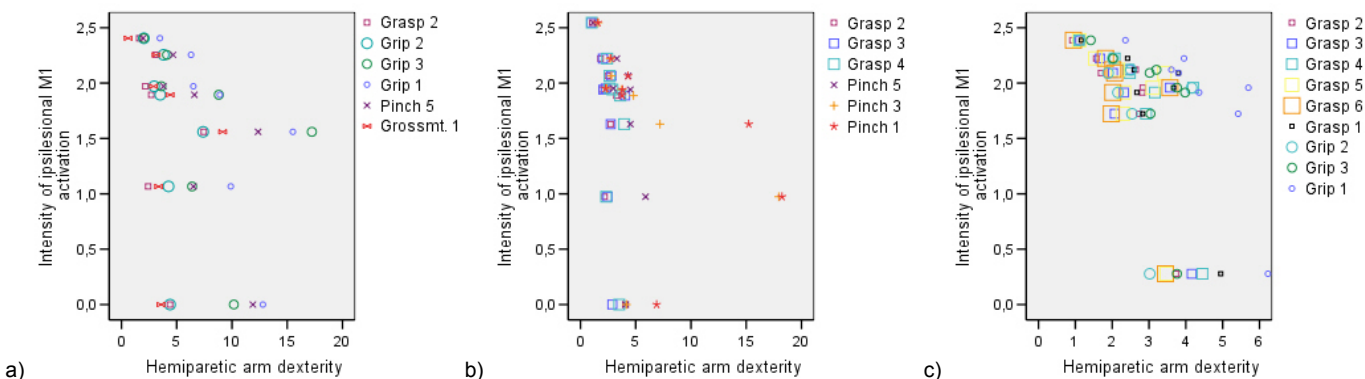

Figure 1. Relationship between intensity of ipsilesional M1 activation and Action research arm test skills (s) performed by the hemiparetic upper extremity in the 1st week (a), 3rd week (b), and 3 months (c) after stroke.

Conclusion

Recovery of HPE function correlated well with the intensity and/or area of M1 cortex activation mainly in the ipsilesional hemisphere. Interestingly, more correlations were established with dexterity (negative direction) than with strength (positive direction), more correlations were observed 3 months after stroke than earlier, and more correlations were established with intensity in contrast to area of M1 activation. The findings might indicate the importance of functional training and use of HPE in promoting the process of cortex reorganization.

References

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