

## Application study of DTI and fMRI in the rehabilitation of ischemic stroke patients with 3T

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**Synopsis:** Rehabilitation therapy is important for stroke patients to recover their motor ability, but the mechanism of brain compensation and imaging criteria for prognosticating rehabilitation treatment effect are unclear. We observed active clenching fMRI of 24 patients from Aug 2002 to Aug 2003. We found that the fMRI images are different among patients with different hand motor ability according to Twitchell-Brunnstrom six stages, which suggests different brain area compensation result in different degree of hand motor ability recovery. Combining DTI analysis of those patients, the disruption of anterior 3/5 part of posterior limb of internal capsule, which is the cortical spinal cord locates, is related to different stage of hand motor ability. This result suggested that the severity of disruption of the cortical spinal cord may be used to predict the prognosis of rehabilitation treatment. DTI and fMRI are useful for the exploration the mechanism of rehabilitation.

**Purpose:** To observe functional brain compensation by active clenching fMRI of ischemic stroke patients with rehabilitation treatment, and evaluate DTI in predicting rehabilitation treatment effect.

**Method and materials:** 24 patients from Aug 2002 to Aug 2003 were analyzed. All of them accepted regular MR examination, DTI(EPI sequence TR/TE =8000/85, b value 1500s/mm<sup>2</sup>) and box-design fMRI of active clenching (EPI sequence TR/TE =3000/30) with GE Signa 3T. FA and AI of bilateral anterior 3/5 part of posterior limb of internal capsule were calculated and compared, which is the cortical spinal cord locates. 3D tractography of bilateral cortical spinal cord in these patients were also made. fMRI data were analyzed by SPM99. Twitchell-Brunnstrom six stages was used to evaluate the hand motor ability.

**Results:** According to the recovery stages of Twitchell-Brunnstrom standard, lesion's localization and fMRI images, the patients were divided into 6 groups. 1) L1 group, lesion in the left hemisphere, the hand movement ability ranged in □ or □ grade. 2) L3-1 group, lesion in the left hemisphere, the hand movement ability ranged in □ or □ grade. The fMRI showed as ipsilateral activation. 3) L3-2 group, lesion in the left hemisphere, the hand movement ability ranged in □ or □ grade. The fMRI showed as bilateral activation. 4) L5 group, lesion in the left hemisphere, the hand movement ability ranged in □ or □ grade. 5) R1 group, lesion in the right hemisphere, the hand movement ability ranged in □ or □ grade. 6) R5 group, lesion in the right hemisphere, the hand movement ability ranged in □ grade.

The group analysis of active fMRI of the patients of L1, L3-1, R1 groups showed activations in ipsilateral SMC (sensorimotor cortex). The active fMRI of the patients of L3-2, L5, R5 groups showed bilateral SMC activations with ipsilateral SMC activation larger than contralateral side. Comparing with the active activation of volunteers, bilateral Brodmann 3, 5 and/or 7 area of L5, R5 groups were activated. Ipsilateral Brodmann 7, 40 area of R1 groups and bilateral SMA (supplementary motor area) of L3-2 group were activated.

The status of anterior 3/5 part of posterior limb of internal capsule was divided into 3 groups. Group 1 is significant disruption, which means larger than 2/3 part of this area was destroyed by ischemic lesion, including 6 patients. Group 2 is partial disruption, which means less than 2/3 area destroyed including 13 patients. Group 3 means bilateral cortical spinal cord kept intact because there was no invasion in this area by ischemic lesion, including 5 patients.

FA and AI value anterior 3/5 part of posterior limb of internal capsule in the lesion side of patients

in group 1 and 2 are lower than contralateral side,  $P < 0.01$  by paired t-test. There was no significant difference in group 3. Spearman correlation study showed the severity of interruption of the cortical spinal cord related with Twitchell-Brunstrom hand motor ability stages,  $P < 0.01$ .

**Conclusions:** Our result suggests different brain area compensation result in different degree of hand motor ability recovery; the severity of disruption of the cortical spinal cord may be used to predict the prognosis of rehabilitation treatment. DTI and fMRI are useful for the exploration the mechanism of rehabilitation.

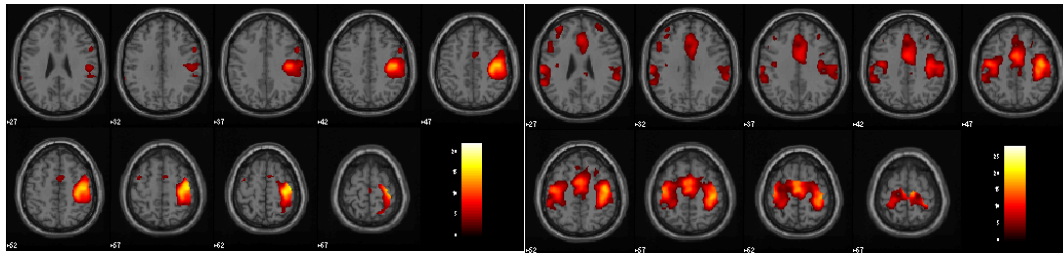


Fig1

Fig2

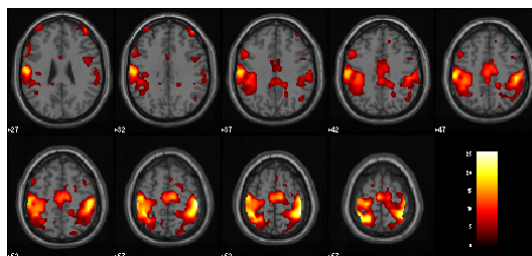


Fig3

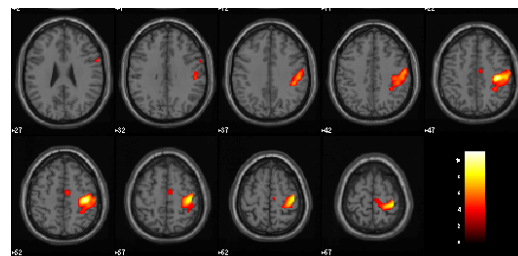


Fig4

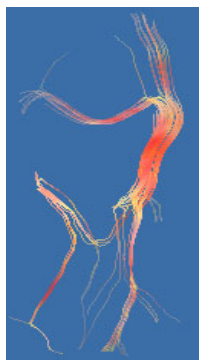


Fig5

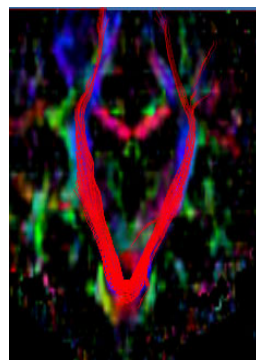


Fig6

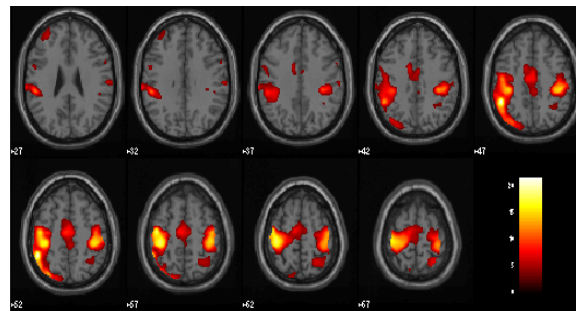


Fig 7

Fig 1 is fMRI of L1 group patients. Fig 2 is fMRI of L3-2 group patients. Fig 3 is fMRI of R5 group patients. Fig4 and Fig5 are fMRI and 3D tractography images of a patient with Twitchell-Brunstrom □ stage, which means the hand with sever hemiplegia. 3D tractography image of this patient showed the cortical spinal cord interrupted thoroughly. Fig6 and Fig7 are 3D tractography and fMRI images with Twitchell-Brunstrom stage □. 3D tractography image of this patient showed the cortical spinal cord kept intact.