

: (functional magnetic resonance imaging: fMRI)
 fMRI : 7 가 .
 가 , fMRI , 가 . 1.5T
 MR EPI(echo planar image) - BOLD(blood oxygen level dependant)
 (postprocessing of image) SPM
 $p < 0.01$ $p < 0.001$.
 : 7 14 - (primary
 sensory - motor cortex) (supplementary motor cortex)
 , 가 가 12 , 가
 가 11 .
 (pixel) 가
 3 .
 : fMRI 가

tomography: PET) (positron emission fMRI
 1990 가 fMRI
 (1 - 2). (functional mag -
 netic resonance imaging: fMRI) PET
 , 가
 가 (3 - 8). 가 7 가 6
 , 가 1 . 26
 , fMRI (23 - 30) .
 가 , 1.5T (GE
 medical system, Milwaukee, U.S.A.) echo planar image
 (EPI) blood oxygen level dependant (BOLD
) . Inter - leaved gradient
 echo single shot EPI , (TR)/

2001 7 20 2001 12 17

(TE) 3000/60 msec, (flip angle) 90°; matrix 64 × 64, 5 mm, no slice gap, FOV 24 × 24 cm (anterior commissure) (posterior commissure) 17

EPI (TR/TE 417/9 msec, matrix 256 × 256, 5 mm, no slice gap, FOV 24 × 24 cm) T1 -

4 5 가 10 30 EPI (equilibrium state) 12 (dummy scan) 가 가 [(42) - (30) - (30) - (30) - (30) - (30) - (30)].

fMRI statistical parametric mapping (SPM 96, MRC Cyclotron Unit, London, UK) (misalignment) Automated Image Reconstruction(AIR) (noise) gaussian filtering high pass filtering ANCOVA (analysis of covariance) (global normalization) t - test SPMt(statistical parametric map using t - test) T1 -

t - test 가 p <0.01 p <0.001 Wilcoxon Rank Sum method p <0.05 가 가 가 fMRI 가 . Grade 1 weak scattered, clustered signals mixed with abundant noise signal, Grade 2 clustered signals mixed with less noise signal, Grade 3 clustered signals without noise signal, Grade 4 strong clustered signals

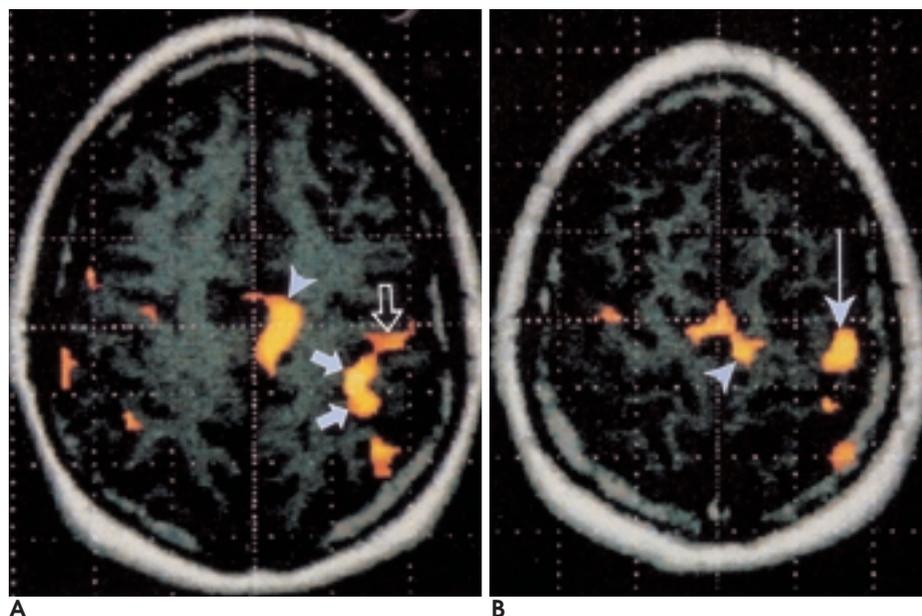


Fig. 1. Functional MR images during active right hand motor stimuli. Activation map images of the upper two (A, B) levels of the brains show bilateral activated signals in the premotor area (long arrow), supramarginal gyrus (short arrows), superior temporal (blank arrow) and supplement motor area (arrow head). The activated signals are stronger in the left premotor and superior parietal cortex than in the right side.

(Fig. 2) (Table 1).

78

($p < 0.05$) (Table 2).

가 (Fig. 2)

(Table 1).

344 (Fig. 1) (Table 1).

(Table

2).

(fMRI) BOLD

EPI

Table 1. The Numbers of the Presence of the Activated Signals During Active and Passive Motor Stimuli

(N = 14)

	Active motor stimuli		Passive motor stimuli	
	Contralateral	Ipsilateral	Contralateral	Ipsilateral
Primary sensory-motor cortex	14	12	14	0
Supplementary motor cortex	14	11	3	0

Table 2. Grade and Number of the Activated Pixels During Active and Passive Motion

* $p < 0.05$

	Grade 1	Grade 2	Grade 3	Grade 4	Total
Active	107 ± 35	107 ± 24	72 ± 23	59 ± 29	344 ± 89*
Passive	20 ± 04	33 ± 07	17 ± 09	6 ± 07	78 ± 25*

Grade 1: Weak scattered, clustered signals mixed with abundant noise signal.

Grade 2: Clustered signals mixed with less noise signal.

Grade 3: Clustered signals without noise signal.

Grade 4: Strong clustered signals.

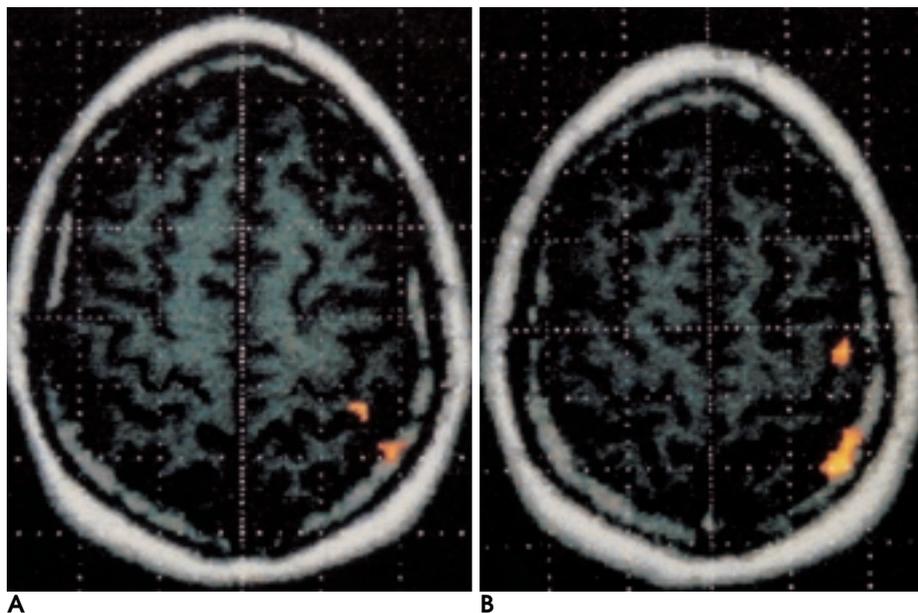


Fig. 2. Functional MR images during passive right hand motor stimuli. Activation map images of the upper two (A, B) levels of the brains during passive motor stimuli show the activated signals in the similar areas with active motor stimuli. However, the activated signals are much weaker during passive stimuli than those during active stimuli, and the supplement motor area is not seen in passive motor stimuli.

:
 . fMRI 가 BOLD ,
 (deoxyhemoglobin) 가 .
 (9 - 10). , 가
 가 가
 가가 , Mima (16) PET
 (paramagnetic material) , 가
 가 가 , 가
 가 (9 - 10). (medial premotor cortex)
 (functional brain mapping) MR MR (17 - 18),
 (postprocessing) . fMRI (19) (lateral premotor cortex) 가
 (20 - 22). 가
 가 , 가 10 - 15%
 fMRI (3, 11 - 13). (23).
 1990 - fMRI
 cognitive) , 가 (high
 가 (14 3) 가
 (premotor cortex) (pari -
 etal cortex) 가
 (precentral gyrus) (paracentral gyrus) 가 . Yetkin (4, 12)
 (Brodmann area 4), 가
 (Brodmann area 가 가
 6) , ,
 (lateral cortical spinal tract)
 (rubrospinal tract) (14). fMRI
 fMRI
 (3) (pre - supple -
 mentary motor area), (supplementary motor
 area proper, (supplementary eye field) 가
 (14) 1.5T MR 2 - 4%
 (15). (1), 가
 (central sul -
 cus) (precentral gyrus) MR
 가 ,
 72 - 75%, 가 25 - 27%
 EPI t - test
 fMRI가 가 17 - 20

Functional MR Imaging of the Motor Cortex in Active and Passive Movement: Qualitative and Quantitative Changes¹

Ki Bong Yu, M.D., Myung Kwan Lim, M.D., Hyung Jin Kim, M.D.,
Jun Soo Byun, M.D., Young Kook Cho, M.D., Chang Hae Suh, M.D.

¹Department of Radiology, Inha University College of Medicine

Purpose: To compare functional MR imaging of the motor cortex during active and passive movement.

Materials and Methods: Seven healthy, right-handed volunteers (M:F = 6:1; age:25 - 30 years) were included in this study. A 1.5-T whole body scanner and the multislice EPI BOLD method were used. The motor paradigm was flexion-extension of a thumb against rest. In the active motion task, the thumb was flexed voluntarily once a second, while in the passive task, it was tied with a thread and pulled to flex and extend passively at the same interval and with the same intensity as in the active task. For image postprocessing, an SPM 96 program was used. The sites, numbers, and signal intensity of the activated pixels were determined, and the threshold for significance was set at $p < 0.001$ to $p < 0.01$.

Results: In the active motion task, strong activation at the contralateral side of the primary sensorimotor cortex and supplementary motor cortex occurred in all 14 examples in all seven volunteers. Additionally, the ipsilateral primary sensorimotor cortex and supplementary motor area were activated in 12/14 and 11/14 such tasks, respectively. During passive motion tasks, on the other hand, weak activation occurred at the contralateral side of the primary sensorimotor cortex in all cases, but in the contralateral supplementary motor cortex in only three. In the ipsilateral primary sensorimotor cortex and supplementary motor area, there was no activation.

Conclusion: Compared with the active motion task, activation occurring in the contralateral primary sensorimotor cortex and supplementary cortex was weaker and less frequent during the passive task, and during this latter, the ipsilateral motor cortex remained inactive. These results may be useful for the clinical application of functional MR imaging in unconscious patients or in animal studies.

Index words : Brain, blood flow
Brain, function
Magnetic resonance(MR), comparative studies

Address reprint requests to : Myung Kwan Lim, M.D., Department of Radiology, Inha University College of Medicine,
7-206, 3rd Street, Shinheung-dong, Choong-gu, Incheon 400-103, South Korea.
Tel. 82-32-890-2769 Fax. 82-32-890-2743 E-mail: kanlim@chollian.net