BRAIN RESEARCH 1317 (2010) 211–217

available at www.sciencedirect.com

ScienceDirect

www.elsevier.com/locate/brainres

BRAIN RESEARCH

Research Report

Target-specific rCBF changes induced by 0.3-T static magnetic field exposure on the brain

Seungyeon Kim[a,1], Yong-An Chung[b,1], Chang-Uk Lee[c], Jeong-Ho Chae[c], Rahyeong Juh[d], Jaeseung Jeong[a,*]

[a]Department of Bio and Brain Engineering, Korea Advanced Institute of Science and Technology (KAIST), Yuseong-gu, Kuseong-dong, 373-1 Daejeon, 305-701 South Korea
[b]Department of Radiology, Institute of Catholic Integrative Medicine, Incheon St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Incheon, 403-720 Republic of Korea
[c]Department of Psychiatry, College of Medicine, The Catholic University of Korea, Seoul, 150-713 Republic of Korea
[d]Department of Biomedical Engineering, College of Medicine, The Catholic University of Korea, Seoul, 150-713 Republic of Korea

ARTICLE INFO

Article history:
Accepted 22 October 2009
Available online 30 October 2009

Keywords:
Static magnetic field
Cerebral blood flow
SPECT
SPM

ABSTRACT

The magnetic field has been regarded as both harmful and beneficial for its applications on human brains including transcranial magnetic stimulation (TMS), but its effects still remain in question. Here, we determined using single photon emission computed tomography (SPECT) if 0.3-T static magnetic field could alter regional cerebral blood flow (rCBF) in target and other brain regions in healthy subjects. The permanent static magnet (0.3 T, unipolar, disk shaped, 4 cm diameter and 1 cm thick) was placed on the right frontotemporal region of the brain for each of 14 healthy subjects. Tc-99m ECD perfusion SPECT was taken to compare the CBF patterns in the subjects exposed to the static magnet field with those of the resting and sham conditions. We found that the rCBF was significantly increased in the right frontal and parietal regions and the right insula. On the other hand, rCBF was rather decreased in the left frontal and left parietal regions ($P < 0.05$). These results of this basic study suggest that 0.3-T static magnetic field induces an increase in rCBF in the targeted brain areas non-invasively, which may result from a decrease in rCBF in contralateral regions.

1. Introduction

Magnetic fields have long been considered as a potentially beneficial therapeutic application. When diamagnetic materials such as fibrin, collagen, osteoblasts and red blood cells (RBC) are exposed to static gradient magnetic fields, they align either parallel or perpendicular to the direction of the magnetic field depending on the magnetic anisotropy of the materials in question (Torbet et al., 1981). Induced magnetic fields in the brain might affect the membrane or synaptic properties of neurons, brain functions and thus behavior. Many studies have consequently applied magnetic fields to proximal areas of pain and inflammation of patients to alleviate pain and discomfort due to arthritis, headaches, sciatica, heel spurs, migraine and so forth (for example, Stuchly, 1986). The exposure to magnetic fields had opened up a new range of applications to facilitate bone growth and speed the healing of fractures.

* Corresponding author. Fax: +82 42 350 4310.
E-mail address: jsjeong@kaist.ac.kr (J. Jeong).
[1] Both authors are equally contributed.

0006-8993/$ – see front matter © 2009 Published by Elsevier B.V.
doi:10.1016/j.brainres.2009.10.057

Particularly, magnetic stimulation has been used as a promising non-invasive modality for modulating neural activities in humans. Repetitive transcranial magnetic stimulation (rTMS) is a less painful, non-invasive method than direct electric stimulations through surface electrodes placed on the head. Thus, rTMS has become an important tool for modulating the functional organization of the brain in patients with neurological or psychiatric disorders. It has been reported to be a potentially safe and useful treatment for various brain disorders, such as depression and Parkinson's disease (Pascual-Leone et al., 1994; Chen et al., 2004; Hansen et al., 2004; Boggio et al., 2005; Alisauskiene et al., 2005; Canavero and Bonicalzi, 2005). In addition, brain stimulation using magnetic fields is, so far, not known to have serious side effects compared with electrical stimulation.

However, the clinical utility of TMS as therapeutic application is only supported by isolated anecdotes, yet not fully supported by comprehensive epidemiological and clinical experimental findings (Aleman et al., 2007; Lam et al., 2008). Furthermore, epidemiological studies have shown that oscillating electromagnetic fields of various frequencies including the magnetic fields produced by power lines of high-intensity voltage can lead to leukemia and brain cancers (Wertheimer and Leeper, 1982; Thomas et al., 1987; Wassermann, 1998). Thus, the effects of magnetic fields on pathophysiological brain functions depending on the types (static or oscillating) and intensity (low or high level) of magnetic field or the target region of the brain are still not known.

Thus, as a basic investigation, this study aimed to assess single photon emission computed tomography (SPECT) if 0.3-T static gradient magnetic field induce increase or decrease in the rCBF in target or other brain regions in healthy subjects. Our hypothesis was that (1) static magnet field would exert changes in rCBF flows in the target-specific regions of the brain and that (2) this target-specific alterations in rCBF due to magnetic field of 0.3 T might be associated with rCBF alterations in other brain regions. To the best of our know-

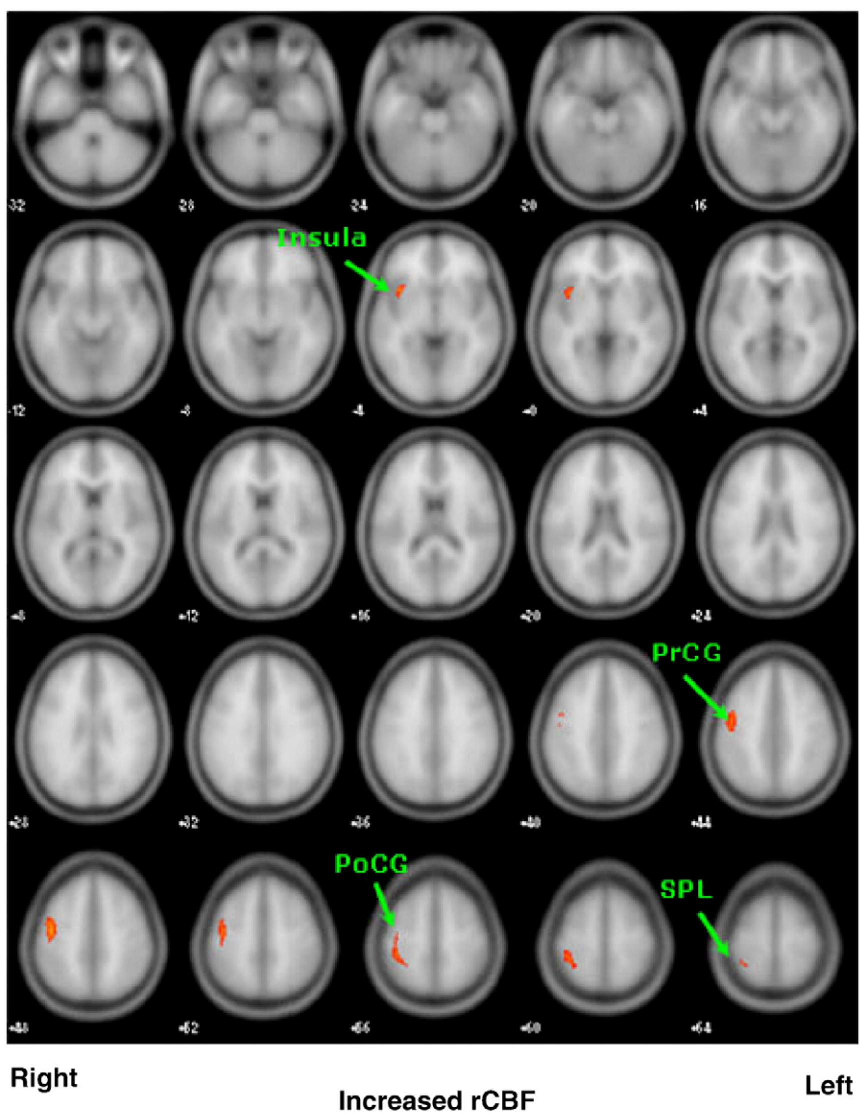

Fig. 1 – The 0.3-T magnetic field of permanent, static magnet induced rCBF increase in target regions in axial sections (PrCG: precentral gyrus; PoCG: postcentral gyrus; SPL: superior parietal lobule).