ROLE OF FUNCTIONAL MRI IN CORTICAL BRAIN MAPPING

Essay

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SUMMARY & CONCLUSION

The first generation of brain imaging techniques has perfected our ability to visualize macroscopic structural lesions. For many disorders of the brain, however, dysfunction is caused by impaired neuronal physiology more than by altered gross anatomy.

Because of this patho-physiological feature, many of these disorders cannot be visualized with 'structural' imaging, and are even invisible under the microscope. By perfecting the ability to visualize physiological dysfunction, the next generation of brain imaging – functional imaging – will not only revolutionize the clinical management but also contribute to our basic understanding of this class of disease.

Neurosurgery in functionally important brain sites carries a high risk for surgery induced neurological deficits. Reduction of morbidity associated with treatment is of utmost importance, neurosurgery aims to eliminate as much of the lesion as safely possible by maintaining important functions of the brain. This is achieved by application of new diagnostic technologies like fMRI which plays an important role in this field.

Functional MR imaging can be used to identify eloquent cortical regions, it enables the surgeon to take therapeutic decisions and to advise the patient carefully about the risks and also the benefits of the procedure. In certain patients, surgical

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List of Abbreviations

Abb.	Full term
AC	*Auditory cortex*
AD	*Alzheimer's disease*
ADHD	*Attention deficit hyperactive disorder*
ADP	*Adenosine diphosphate*
AG	*Angular gyrus*
ATP	*Adenosine triphosphate*
AVM	*Arterio-venous malformation*
BA	*Broadman area*
BOLD	*Blood oxygen level dependent*
CBF	*Cerebral blood flow*
CBV	*Cerebral blood volume*
CNS	*Central nervous system*
CPT	*Current procedural terminology*
CPUs	*Central processing units*
CS	*Central sulcus*
DES	*Direct electrical stimualtion*
DTI	*Diffusion tensor imaging*
EEG	*Electroencephalography*
FDA	*Food and drug adminisration*
FDG	*Fluoro deoxy glucose*
FLAIR	*Fluid attenuation inversion recovery*
fMRI	*Functional MRI*
GE-EPI	*Gradient echo echo planar imaging*

Hb	*Hemoglobin*
HRF	*Hemodynamic reference function*
IAP	*Intra carotid Amobarbital procedure*
ICA	*Internal carotid artery*
IED	*Interictal epileptiform discharges*
IFG	*Inferior frontal gyrus*
IOG	*Inferior occipital gyrus*
IPL	*Inferior parietal lobule*
ITG	*Inferior temporal gyrus*
ITS	*Inferior temporal sulcus*
IV	*Intravenous*
LI	*Lateralization index*
MEG	*Magnetoencephalography*
MFG	*Middle frontal gyrus*
MOG	*Middle occipital gyrus*
MRS	*Magnetic resonance spectroscopy*
MSI	*Magnetic source imaging*
MTG	*Middle temporal gyrus*
MTL	*Medial temporal lobe*
PACS	*Picture archiving & communication system servers*
paraCL	*paracentral lobule*
PET	*Positron emission tomography*
post CG	*Postcentral gyrus*
preCG	*Precentral gyrus*
rCBF	*Regional cerebral blood flow*
rCBV	*Regional cerebral blood volume*

S	*Seconds*
SFG	*Superior frontal gyrus*
SG	*Sentence generation*
SI	*Signal intensity*
SMA	*Supplementary motor area*
SMA	*Sensory motor area*
SMG	*Supramarginal gyrus*
SNR	*Signal to noise ratio*
SOG	*Superior occipital gyrus*
SOS	*Superior occipital sulcus*
SPECT	*Single photon emission computed tomography*
SPL	*Superior parietal lobule*
SPM	*Satistical parametric map*
STG	*Superior temporal gyrus*
STS	*Superior temporal sulcus*
subCG	*Subcentral gyrus*
T	*Tesla*
TL	*Temporal lobe*
TLE	*Temporal lobe epilepsy*
WA	*Wernick's area*
WG	*Word generation*

INTRODUCTION

The first generation of brain imaging techniques has perfected our ability to visualize structural lesions as neoplasms, strokes, infections, sclerotic plaques, hydrocephalus…etc. For many disorders of the brain, however, dysfunction is caused by impaired neuronal physiology more than by altered gross anatomy; these include many developmental disorders, most psychiatric diseases, age-related cognitive decline, and even the earliest stages of neurodegeneration. Because of this pathophysiological feature, many of these disorders cannot be visualized with structural imaging, and are even invisible under the microscope. By perfecting the ability to visualize physiological dysfunction, the next generation of brain imaging – functional imaging – will not only revolutionize the clinical management but also contribute to our basic understanding of this class of disease ***(Logothetis & Pfeuffer, 2004 (67)).***

Functional MRI (fMRI) can image the hemodynamic and metabolic changes that are associated with human brain functions such as vision, motor skills, language, memory, and mental processes ***(Richardson et al., 2004 (98)).***

Functional MRI (fMRI) refers to the demonstration of brain function with neuro-anatomic localization on a real-time basis. Functional MRI is performed using BOLD (Blood Oxygen Level Dependant) technique. The principle of the

BOLD technique is that performing a predefined cognitive task leads to regionally increased neuronal activity and localized hemodynamic changes that produce a signal response ***(Pillai, 2010 (92)).***

Although positron emission tomography (PET), and, more recently, magnetoencephalography (MEG), also have provided opportunities to assess brain function non-invasively, the combined spatial and temporal resolution of fMRI, the wider availability of MRI scanners, and the broad range of available activation paradigms confer distinct advantages over these alternative approaches to functional neuroimaging ***(Moritz and Haughton, 2003 (77)).***

The BOLD fMRI examination for preoperative and intra-operative neurological guidance can facilitate planning of surgery, shorten the duration of the operation and anesthesia time and may alleviate the need to awaken the patient during the operation for language and motor mapping ***(Moritz & Haughton, 2003 (77)).***

In the past two decades fMRI has stretched its horizon from being a mere research tool to a highly relevant clinical investigation for surgical planning. Its role in dyslexia, Alzheimer disease, brain AVM, psychological disorder and assessment of brain plasticity has been recognized and increasing number of new applications are emerging every day ***(Hashimoto et al., 2010 (48)).***