W5-1: Preoperative Functional Imaging in Epilepsy

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Uncontrolled epilepsy is a serious neurological problem. Epilepsy affects approximately 0.8 percent of the world's population, and at least 1/3 of patients have seizures not controlled by antiepileptic drugs, leading to neuropsychological, social, and economic impairment. Resective surgery can lead to seizure freedom in about 60% of patients, and markedly reduced seizure frequency in an additional 20-30%. One of the main surgical risks is compromise of brain regions crucial for higher cortical function, particularly language. Standard preoperative functional evaluation includes the intracarotid amytal procedure (IAP), and invasive or intraoperative electrical stimulation mapping (ESM). These techniques increase the expense and risk of surgical evaluation. Moreover, they allow very limited testing coverage and time, rarely can be repeated, and are difficult to perform in children, for whom surgery is being performed increasingly, in order to obviate the effect of uncontrolled epilepsy during developmental years. fMRI and MEG offer increasingly attractive alternative approaches. Studies in adults and children show that fMRI can map language lateralization with 90% agreement with IAP. The theoretical difference between the procedures (functional imaging detects regions participating in a task, while IAP and ESM detect regions associated with task impairment) is of uncertain clinical significance. For fMRI, a battery of tests is more accurate than a single activation procedure. With age-appropriate stimuli, fMRI can be performed in children seven years old or younger. fMRI also can study the effects of epilepsy and its etiologies on the functional anatomy of language. MEG offers better time resolution, but inferior spatial resolution than fMRI. Combining the two approaches may enhance their value.

W5-2: Expressive and receptive language areas determined by a Non-Invasive reliable method Co-Utilizing fMRI and MEG

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OBJECTIVE: It is known that functional magnetic resonance imaging (fMRI) and magnetoencephalography (MEG) are sensitive to the frontal and temporal language function, respectively. We, therefore, established combined utilization of fMRI and MEG to make reliable identification of the global language dominance in the pathological brain conditions. METHODS: We investigated 117 patients with brain lesions whose language dominance was successfully confirmed by the Wada test. All patients were asked to generate verbs related to acoustically presented nouns (verb generation) for fMRI and to read 3-letter words for fMRI and MEG. The most prominent RESULTS: fMRI typically showed prominent activations in the inferior and middle frontal gyri, whereas calculated dipoles on MEG typically clustered in the superior temporal region and the fusiform gyrus of the dominant hemisphere. A total of 87 patients were further analyzed using useful data from both the combined method and the Wada test. Remarkably, in the 87 patients, we observed a 100% match of the combination method results on the language dominance with the Wada test results, including the two cases that showed expressive and receptive language areas dissociated into bilateral hemispheres. CONCLUSION: The results demonstrate that this non-invasive and repeatable method is not only highly reliable in determining the language dominance, but can also locate the expressive and receptive language areas separately. The method may be a potent alternative to invasive procedures of the Wada test, and useful in treating patients with brain lesions.
Abstract / Workshop 5

W5-3: fMRI and MEG: technical and methodological advantages and pitfalls

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Functional magnetic resonance imaging (fMRI) and magnetoencephalography (MEG) are non-invasive neuroimaging technologies that have demonstrated, and continue to demonstrate, great potential for both research and clinical applications. Both technologies offer valuable information regarding the mechanisms underlying sensory and cognitive function in the brain. fMRI findings reflect hemodynamic changes associated with function; while MEG results measure the magnetic fields produced by neuronal conduction. As such, both techniques offer distinct advantages and distinct limitations. This workshop session will begin with an overview of fMRI and MEG theory. There will be a discussion regarding experimental design, stimulus presentation, data acquisition protocols, post-processing, and statistical analysis strategies. Finally, the advantages and disadvantages of each technique will be compared. As these technologies continue to gain wider acceptance and are increasingly applied, there is a need to understand the relative merits of each technology so that new research questions can be matched with the technology best suited for elucidating that answer. When mindful of the limitations and confounds of each methodology, both fMRI and MEG are powerful tools for investigating the neurobiology of human cognitive and sensory functions, for understanding cognitive development and maturation, and for the examination of neurological disease processes.

W5-4: Structural and metabolic correlates of functional anatomy: evidence from DTI and MRS.

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Pathologic conditions in the human brain can not sufficiently be depicted from conventional magnetic resonance imaging (MRI) alone. We investigated the clinical use of new MR imaging modalities, as magnetic resonance spectroscopic imaging (MRS) and MR diffusion tensor imaging (DTI) for glioma and epilepsy diagnostics and surgery. MRS is a noninvasive tool for investigating the spatial distribution of metabolic changes in brain lesions. DTI allows the macroscopical detection of anisotropic water diffusion due to elongated structures such as white matter bundles. Fiber tractography of DTI data allows the reconstruction of white matter tracts. Brain tumors show increased levels of choline-containing compounds (Cho) and a reduction in N-acetyl-aspartate (NAA) and creatine (tCr). The range of Cho increase and NAA decrease is compatible with the range of tumor infiltration. Furthermore we correlated the changes in fractional anisotropy (FA) and mean diffusivity (MD) using diffusion tensor MR imaging (DTI) with the degree of tumor cell infiltration in gliomas with the purpose to assess the extent of tumor cell infiltration in brain fiber tracks. We also used MRS to assess metabolic changes in temporal lobe epilepsy and correlations between metabolic alterations, seizures, and epileptic discharges in EEG. In addition we investigated the potential use of MRS in the identification of hippocampal sclerosis in patients with TLE. This talk summarizes our experience of the clinical application of MRS and DTI in glioma and epilepsy treatment.

W6-1: Magnetoencephalography analysis to demonstrate widespread or multi-focal epileptogenic regions

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Purpose: In the analyses of MEG for the epileptic patients, conventional MEG analyzing tool sometimes could not define the epileptogenic area. Single dipole method (SDM) are compatible to solve the localized epileptic MEG discharges and demonstrate the equivalent current dipoles (ECDs). Diffuse or multi-focal epileptic activities were not suitable for the ECD analyses, since the formula of SDM underlined by a circumscribed epileptogenic area. In this present study, we tried to make alternative analyzing method to demonstrate the widespread or multi-focal