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SHORT COMMUNICATION

Quantifying the contribution of video in combined video-magnetoencephalographic ictal recordings of epilepsy patients

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Summary
Introduction: Magnetoencephalography (MEG) measures magnetic fields generated by neuronal currents. MEG is complementary to EEG. Considerable body of evidence indicates that ictal MEG recordings can provide useful information for pre-surgical evaluation of epilepsy patients alongside the more established long-term ictal video-EEG. Ictal MEG is recorded in some epilepsy surgery centers. However, a wider adoption of ictal MEG is hampered by lack of tools for synchronized video-MEG recording similar to those of video-EEG.
Methods: We have augmented MEG with a synchronized behavioral video-recording system. To estimate its additional value in ictal recordings, we retrospectively analyzed recordings of 10 epilepsy patients with and without the video.
Results: In six patients out of ten, adding the video substantially changed the resulting interpretations. In all six cases the effect was considerable: the number of detected seizures changed by more than 50%.
Conclusions: Synchronized video and audio recording capabilities are important for effective ictal MEG recordings of epilepsy patients.

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Introduction

Epilepsy

Epilepsy affects about 1 percent of the population, and up to 30 percent of epilepsy patients continue to have seizures despite rational antiepileptic medication (Sander, 1993; Schmidt and Gram, 1995; Wood et al., 1996). Surgical treatment may improve the quality of life of many of these patients. Successful surgery outcome, however, depends critically on precise localization of the epileptogenic zone. Invasive recordings from implanted electrode grids or depth electrodes are currently considered as the ''gold standard'' for such localizations. They can, however, only provide a limited coverage and harbor a risk of complications.

Video-EEG

Besides seizure history and structural MRI, EEG provides the initial information on the patient's epileptogenic zone. In standard clinical practice, EEG traces are augmented by synchronized video recordings that allow detection of lateralizing and localizing seizure symptoms and their correlation to EEG (Lüders, 1992) for e.g., planning of further invasive studies.

Magnetoencephalography

Magnetoencephalography (MEG) is a functional neuroimaging modality based on noninvasive recordings of magnetic fields generated by neuronal currents inside the brain (Hämäläinen et al., 1993). Both EEG and MEG directly record signatures of neuronal currents, but provide complementary information (Cohen and Halgren, 2003). Simultaneous MEG and EEG recordings in epilepsy patients have demonstrated that MEG may contain information that is not available in EEG and that combined EEG—MEG recordings outperform single modalities (Colon et al., 2009; Heers et al., 2010; Iwasaki et al., 2005; Knowlton et al., 1997).

Ictal MEG—EEG recordings (abbreviated as ''MEG'' in the following) promises more precise localization of epileptogenic cortex than ictal EEG and interictal MEG recordings (Medvedovsky et al., 2012). Currently, such recordings are done as a part of preoperative evaluation in some epilepsy surgery centers. Wider use is hampered, among other factors, by lack of video recording functionality similar to that of video-EEG. None of the current commercial MEG manufacturers provides video recording capability. Consequently, some clinical MEG centers have implemented own, custom-built systems (Burgess et al., 2009; Wilenius et al., 2010). Although the arguments in favor of adding video capability to MEG recordings seem plausible, the actual utility of video in such recordings has not yet been objectively evaluated. Here we estimate the contribution of video to the clinical MEG recordings in epilepsy patients by comparing the results of analysis from a group of patients without and with video.

Methods

We retrospectively analyzed ictal MEG recordings of 10 patients. The recordings were done in the BioMag laboratory of the Helsinki University Central Hospital between January and October 2011. The experiment included only analysis of the data recorded in the course of a standard clinical procedure.

Instrumentation

MEG signals were recorded with 306-channel Vectorview MEG system (Elekta Oy, Helsinki, Finland). Patient's video and audio were recorded by a prototype video/MEG system developed by the BioMag laboratory in collaboration with Elekta Oy (see Fig. 1). The audio and video recordings were synchronized to the MEG traces with the accuracy of better than 50 ms.

MEG recording protocol

An individual recording protocol is designed for each epilepsy patient referred for an MEG recording, based on the patient's medical history, results of other neurophysiological and imaging studies, etc. A typical recording consists of 1 to 3 sessions of 2—10 h. Each session contains several 10—20 min recording blocks, separated by gaps of 10 s to tens of minutes. These recording durations allow recording of ictal events in 20—30% of the patients. For a more detailed discussion of various factors (including required recording time) affecting the chances of detecting an ictal event in MEG see (Medvedovsky et al., 2012). The MEG operator marks the blocks containing seizures in a separate paper log.

Data selection

Altogether 25 epilepsy patients were recorded with video-MEG. Ten of them had clearly identifiable seizures during the recording. These ten patients were selected for the study. For each patient, all data blocks with seizures (1—4) were analyzed (see Table 1). In addition, equal number of data blocks without seizures were selected for each patient except for patient 7 where all data blocks (four with seizures and one without) were analyzed.

Data analysis

All selected recordings were stripped of seizure markers (e.g. in the filenames, etc.). The data were then reviewed by a medical doctor experienced in analysis of ictal MEG recordings (J.W.), but not involved in data acquisition. The purpose was to identify the ictal events, without their further analysis. Motion compensation and artifact removal of MEG was done by the tSSS method (Taulu and Simola, 2006). The patients' referrals with all information used during the standard clinical scrutiny were provided for analysis.

The data were visually inspected using a version of Elekta Graph software (Elekta Oy, Helsinki, Finland), modified by the vendor to allow simultaneous playback of audio and