METHODS - ANALYSIS

Improving MEG's source localization accuracy by using continuous head motion detection

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Introduction

The accuracy of any source localization method is strongly influenced by head movements during MEG experiments if no data correction is applied. Especially if long experiments are conducted and/or patients are investigated large motion artifacts from the patient's head can occur. In most MEG laboratories the relative position of the subject's head is determined only before and after the neuromagnetic recordings, where usually one of the two head location measurements are used for further source localization. The major drawback, however, is that any head motion in between will decrease the reconstruction accuracy, since the neuromagnetic field changes refer to only one of the head location measurements. We instead use continuous head motion detection to improve the localization accuracy of MEG.

Methods

Continuous head motion detection was supplied during long lasting MEG experiments ($\geq$ 15 min.) in patients and normal subjects to construct an average head-sensor coordinate system, where epochs including large head motion artifacts can be automatically excluded from analysis. Epochs satisfying adjustable requirements are used to estimate an average sensor frame by averaging the three translation and rotation parameters of each measurement in order to minimize the reconstruction errors of averaged (and non-averaged) MEG data.

The calculated average head sensor frame was used for further source reconstruction in simulations as well as in real MEG data using tactile stimulation (180 epochs). In all measurements head movements ($\leq$ 2 mm were accepted for the averaging process of the MEG signal. For source localization the equivalent current dipole model was applied to the first 100 ms time window (after stimulus onset) to the average MEG signal (and the computer generated data), using both the standard sensor frame provided by the MEG system and the calculated average sensor frame. Mean and standard deviation of the location and orientation vectors were computed for all reconstructed dipoles.

Results

Our head motion recordings during MEG acquisition clearly showed that patients (depending on their conditions) introduce larger head movements ($\leq$ 30 mm) than normal subjects ($\leq$ 5 mm) during long lasting experiments.

The source analysis of both the simulated as well as the real MEG data showed that the source reconstruction accuracy can be improved, by means of a reduced standard deviation of the location and orientation of the current dipole, when epochs including large head motion artifacts are excluded from the analysis and an average sensor frame is used for the source reconstruction of the average MEG signal.

Conclusion

The accuracy of source reconstruction can be improved when information on the actual head position during MEG experiments is available. Our results clearly demonstrate that the information obtained from continuous head motion detection, even in the simplest way by means of an average sensor frame, already leads to an effective improvement of source reconstruction accuracy.