Title: OPM-MEG vs. SQUID-MEG in Epileptic Source Localization: A Cost-Effective Alternative

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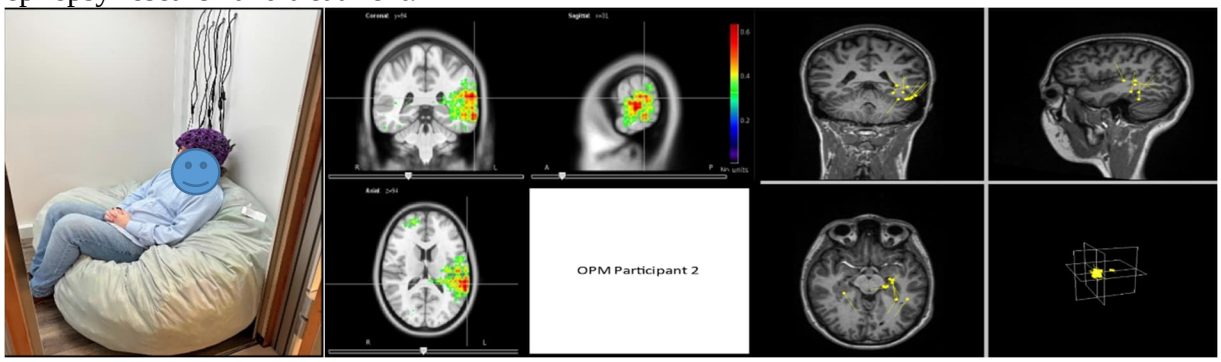
Rationale: Superconducting quantum interference device magnetoencephalography (SQUID-MEG), renowned for its precision, is financially and operationally burdensome due to its liquid helium requirements. This study scrutinizes optically pumped magnetometer magnetoencephalography (OPM-MEG), characterized by a low sensor count (10) and helium-free operation, as a cost-effective and efficient alternative.

Methods: Patients (n = 8) were subjected to sequential SQUID-MEG and OPM-MEG scans. For the SQUID-MEG scans, a traditional clinical protocol was followed. Subsequently, a supplementary protocol was administered using the OPM-MEG system. This supplementary protocol involved a series of tasks designed to stimulate different regions of the brain: a 5-minute resting period, a 2-minute epoch baseline, a motor task, a visual task, and a language task. Localization results from both systems were juxtaposed for direct comparison. Epileptic spikes were identified by a neurophysiologist and modeled using traditional dipole modeling in clinical software for SQUID-MEG, and Linearly Constrained Minimum Variance (LCMV) beamforming in Brainstorm software for OPM-MEG.

Results: OPM-MEG localized tasks and spikes effectively, yielding comparable but not equivalent results to SQUID-MEG. Visual representations substantiate the relative efficacy of both systems. Furthermore, SNR calculations revealed that low sensor count OPM-MEG and traditional SQUID-MEG have comparable SNR in a shielded environment. (14.5 db to 15.1 db respectively)

Conclusions: OPM-MEG serves as a financially viable alternative to SQUID-MEG, particularly in settings with resource constraints. Its comparable performance in both localization and SNR could democratize access to essential neuroimaging tools, thereby expanding the scope of epilepsy research and treatment.



[Figure 1: OPM-MEG rigid helmet system (Left) and participant sitting comfortably in the MSR with the helmet on prior to an experiment. Comparison of spike localization results from OPM-MEG (Middle) and SQUID-MEG (Right) localizations in patient 2. LCMV beamformer was used in the Brainstorm software package for the OPM-MEG localization and the traditional dipole modeling was used for the right SQUID-MEG image.]