Validation of a novel hand-squeezing paradigm for quantification of interhemispheric inhibition (IHI) between motor cortices using MEG

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Background: Several neuroimaging studies of motor control have demonstrated differences in brain activation patterns between stroke patients and healthy controls. Normally, during unilateral motor performance the contralateral primary motor cortex (M1) inhibits the ipsilateral hemisphere. When the contralateral M1 is affected following stroke, inhibition of the ipsilateral hemisphere is lost and results in the increased activation of the contralesional (unaffected) M1. This elevated neural activation in the contralesional hemisphere may be evidence of that hemisphere taking over function in a helpful manner, but may also represent a pathological, maladaptive process that should be suppressed. Currently, there is much interest in the increased interhemispheric inhibition (IHI) of the injured hemisphere following stroke, and how it pertains to functional recovery. This highlights the importance of a physiological measure that will allow us to quantify IHI between motor cortices. MEG studies have shown that slow oscillatory activity can be localized specifically to perilesional tissue, as well as a general "slowing" of electrical activity in stroke patients. Based on these findings, MEG-derived measures of spectral slowing could be used as an outcome measure in stroke intervention studies. **Objectives:** The goal of the current study is two-fold: 1) to validate a novel hand-squeezing paradigm, and 2) to use it to characterize an oscillatory marker in MEG that will allow us to quantify IHI between motor cortices and possibly beyond. Given that we eventually want to use this paradigm in stroke patients who may lack the dexterity to push a button with a single finger, we instead use a whole hand squeezing motion performed with a grip force transducing lever. **Methods:** The study paradigm includes right unilateral, left unilateral, in-phase (simultaneous) bilateral, and anti-phase (alternating) bilateral hand squeezes performed at 3 different frequencies (0.5, 1, 2 Hz). In previous fMRI research, similar protocols with continuous finger tapping movements were found to create an ipsilateral deactivation that increases with tapping frequency during dominant right-hand movement. Moreover, research has found reduced non-dominant to dominant motor cortex IHI during in-phase bilateral movement. In anti-phase movements, IHI from moving to non-moving M1 is needed to prevent mirror movement. By including in-phase and anti-phase bilateral movements in our experiment, we will be able to characterize IHI using MEG. A pilot dataset from one right-handed healthy young adult subject was collected for protocol validation. Synthetic aperture magnetometry (SAM) was performed to investigate power differences in the beta-band frequency (15-30 Hz) between conditions (T-value > 2.5). **Results:** Preliminary SAM results show stronger ERD in the right M1 during left-hand movements compared to right-hand movements at slow and fast movement frequencies. Instead of ERD in the left M1 for right- compared to left-hand movements, as might be expected, there was more beta ERD in the left M1 when moving the left hand. This may indicate that the left M1 is involved in moving both hands, and may reflect the brain requiring more neural resources to move the non-dominant hand. Slow frequency anti-phase vs in-phase movements show bilateral M1 ERD. This may indicate that the task is more demanding (more suppressive of beta) in the anti-phase condition, even though there is less raw movement (with both hands moving at 0.5 Hz, each hand in the anti-phase condition is actually moving at 0.25 Hz). **Discussion:** The pilot results validate the use of a continuous hand-squeezing paradigm for evaluating MEG activity in the motor cortex in healthy adults, and may be extended for future research involving stroke patients with upper limb impairments.