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Exploring Cortical Muscle Representations in Patients With Migraine using TMS - A Preliminary Study

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Introduction

Migraine (MIG) remains one of the leading causes of worldwide disability, resulting in 45.1 million years lived with disability at a global prevalence of twelve percent [1, 2]. Convergent multimodal evidence points towards cortical hyperexcitability as one aspect of MIG pathophysiology [3, 4]. Additionally, recent evidence suggests a link between cervical neuromuscular afferences and MIG pathophysiology, potentially mediated at the level of the trigemino-cervical complex (TCC) [4, 5, 6, 7]. In this context, the current preliminary study employed a transcranial magnetic stimulation (TMS) paradigm to investigate cortical motor representations of the trapezius muscles in MIG patients and healthy controls (HC), given its innervation profile (C1-C3) and role within the TCC.

Methods

We prospectively recruited 12 MIG patients, who were matched with HC based on the criteria of body mass index (BMI), age, and sex. Neuronavigated TMS (nTMS) and electromyography (EMG) were used to create cortical motor representation maps via motor evoked potentials (MEPs) of the medial (TrM) and lateral (TrL) trapezius muscles on both hemispheres, with all MIG patients being investigated during inter-ictal intervals. The EMG recordings from the biceps brachii (BI) were simultaneously acquired as a control muscle. After motor hotspot determination and identification of optimal e-field orientation, the resting motor threshold (rMT) was determined for either TrM or TrL. Subsequently, cortical motor representations of the TrM and TrL were mapped using an intensity of 105% rMT. The stimulation intensities and MEP amplitudes were extracted for comparisons between MIG and HC groups.

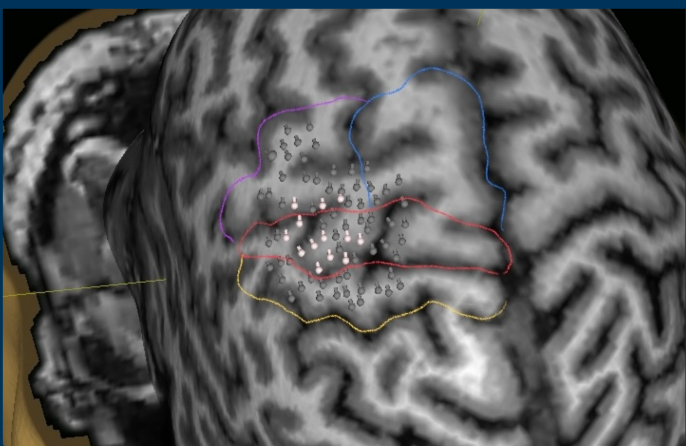

Figure 1: Exemplary screenshot of the left hemisphere of a migraine (MIG) patient with markings of anatomical areas such as the primary motor cortex (M1) in red, the premotor cortex (PMA) in blue, the supplementary motor area (SMA) in pink and the primary somatosensory cortex (S1) in yellow. The white pins indicate motor-positive stimulation points whereas the grey pins indicate motor-negative stimulation points.

Results

Mean age for both groups was 26±3 years, with a sex distribution of 11 females and 1 male per group. The rMT did not significantly differ between both groups ($p>0.05$). After Bonferroni correction, TrM and BI demonstrated significantly higher MEP amplitudes normalized to stimulation intensity spread over the primary motor cortex (M1), supplementary motor area (SMA), and premotor cortex (PrM) in MIG as compared to HC (TrM: 2.21±1.32 µV vs. 1.90±1.16 µV, $p<0.0006$; BI: 16.21±10.57 µV vs. 14.91±11.10 µV, $p<0.0001$) (Figure 2).

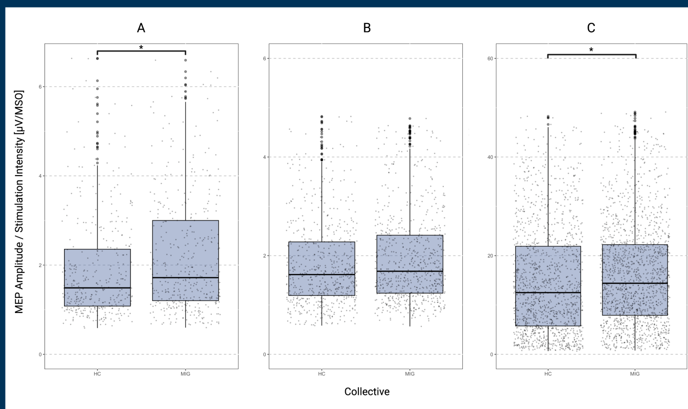

Figure 2: This graph illustrates MEP amplitudes per stimulation intensity of the medial trapezius muscle (TrM, in A), lateral trapezius muscle (TrL, in B), and biceps brachii muscle (BI, in C) of migraine (MIG) patients and healthy controls (HC) derived from cortical motor representation maps. The circles indicate individual MEP amplitudes per stimulation intensity, horizontal lines represent the mean and standard deviation (SD). The difference between MIG and HC was statistically significant for TrM and BI.

Discussion & Conclusion

According to the results of this preliminary study, the observed results for MEPs across different muscle groups may be interpreted in the context of inter-ictal motor hyperexcitability in MIG patients [3, 4]. The group differences were found for the trapezius muscles, involved in the concept of the TCC, but also for the BI, thus potentially emphasizing general hyperresponsiveness over trigemino-cervical specificity. However, given the small sample size and lack of further parameters to assess excitability and neuromodulatory effects in more detail (e.g., active motor threshold, cortical silent period), the findings of this preliminary study need to be followed up by investigations in larger samples. Specifically, future analyses need to take into account the extent and distribution of cortical motor representations, as well as longitudinal measurements across the MIG cycle to further elucidate motor system hyperexcitability.

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