Секция «Клиническая медицина»

Supplementary Motor Area as a Target for Non-Invasive Neuromodulation: A Systematic Review of the Clinical and Basic-Research Approaches

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Supplementary motor area (SMA) is a multifunctional cortical region, which is a promising target for neuromodulation in a wide range of neuropsychiatric disorders, affecting motor and cognitive domains [4]. Repetitive TMS (rTMS) of the SMA has been shown to improve motor symptoms in Parkinson's Disease, Obsessive-Compulsive Disorder, Tourette's syndrome etc. [5,1,2]. However, no systematic review has been conducted on this topic. A current study is dedicated to cover this lack of knowledge and to provide an overview of the SMA functional properties that were examined with rTMS.

This systematic review was conducted and reported according to the Cochrane and PRISMA guidelines (PROSPERO ID - 141289). All original articles published up to 27 July 2019, considering SMA rTMS were extracted from PubMed, Cochrane, and Scopus databases. The qualitative analysis was performed with narrative textual synthesis. Three investigators assessed the studies' quality with the Cochrane risk of bias tool [3]. Articles were divided into two categories: (1) studies in healthy volunteers and (2) studies including patients.

Literature analysis revealed the effect of SMA rTMS neuromodulation on a wide range of the motor control aspects (movement preparation, sequence processing, breathing control), emotions and time processing (Fig.1; Table 1). SMA is reported to have strong functional connectivity with the primary motor cortex, prefrontal cortex, secondary somatosensory cortex, insula, and cerebellum. rTMS of the SMA caused clinical improvement in Parkinson's Disease, Obsessive-Compulsive Disorder, and Tourette's Syndrome patients (Fig.1; Table 2).

Analysis of the SMA rTMS studies showed that SMA is critically involved in motor and cognitive processes. In a clinical setup, SMA seems to be an effective target for neuromodulation in patients with diseases affecting the motor system. This review will be in help for the invention of new neuromodulatory protocols targeting SMA (e.g. catatonia).

Источники и литература

1) Gomes, P. V. O., . . . Rodrigues de Souza, E. (2013). A Randomized, Double-Blind Trial of Repetitive Transcranial Magnetic Stimulation in Obsessive-Compulsive Disorder With Three-Month Follow-Up. The Journal of Neuropsychiatry and Clinical Neurosciences, 24(4), 437–443.
2) Kwon, H. J., Lim, W. S., . . . Paik, K. C. (2011). 1-Hz low frequency repetitive transcranial magnetic stimulation in children with Tourette's syndrome. Neuroscience Letters, 492(1), 1–4.
3) Liberati, A., Altman, D. G., Tetzlaff, J., . . . Moher, D. (2009). The PRISMA statement for reporting systematic reviews and metaanalyses of studies that evaluate healthcare interventions: explanation and elaboration. BMJ, 339(jul21 1), b2700–b2700.

4) Nachev, P., Kennard, C., & Husain, M. (2008). Functional role of the supplementary and pre-supplementary motor areas. Nature Reviews Neuroscience, 9(11), 856–869.

5) Shirota, Y., Ohtsu, H., ... Ugawa, Y. (2013). Supplementary motor area stimulation for Parkinson disease: A randomized controlled study. Neurology, 80(15), 1400–1405.

Иллюстрации

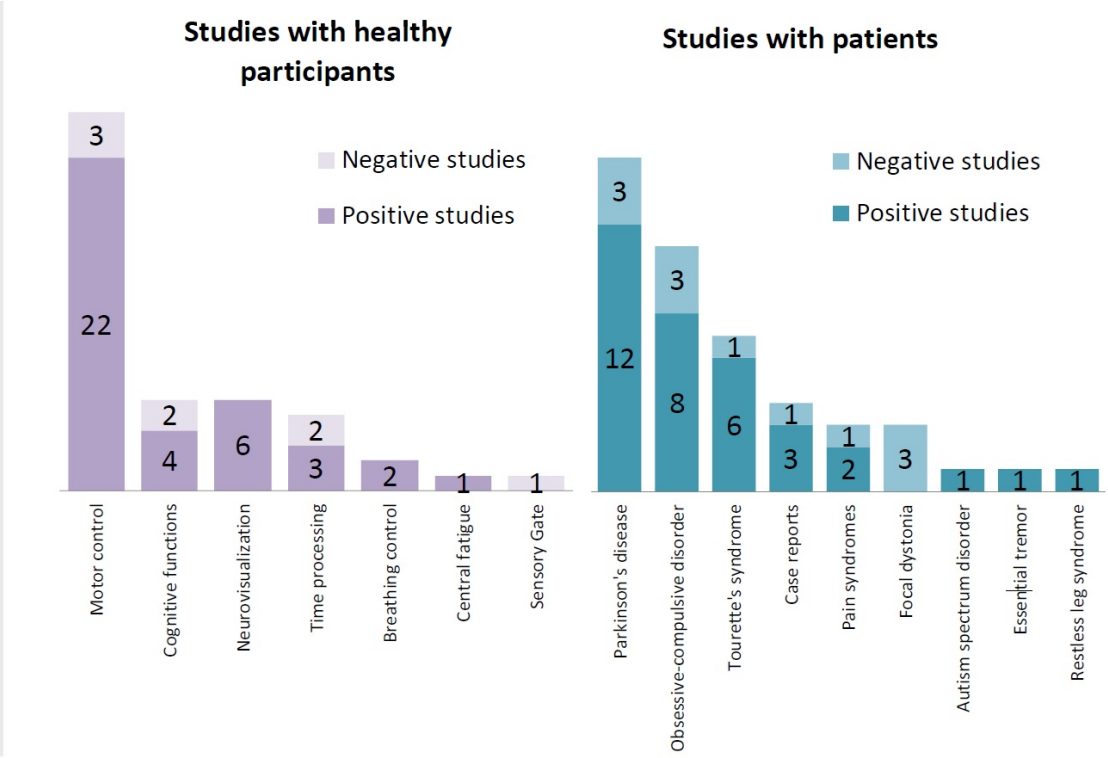

Рис. 1. Figure 1: Representation of the SMA rTMS studies, with healthy volunteers and patients, reflecting positive/negative outcomes, number of studies examined function/disease

Effects of neuromodulation in healthy participants

	Inhibitory rTMS		Excitatory rTMS	
	Motor control		**Motor control**	
SMA	**Increase of success in:** •motor inhibition task performance	6 ... 1 Hz	**Increase of success in:** •sequence learning task performance	20 Hz
			•mental rotation task performance	10 Hz
	Decrease of success in: •sequence learning task performance	1 Hz	•action observation task performance	10 Hz
	•sequence production task performance	1 Hz	• **Increase** of MEPs from diaphragm	5 Hz
	•bimanual coordination task performance	1 Hz	• **Decrease** in load-induced hyperventilation	5 Hz
	•movement preparation task performance	1 Hz		
			• **Decrease** of success in bimanual coordination task performance	5 Hz, 20 Hz
	Decrease of : •MEPs from diaphragm	50 Hz		
	•accuracy in time processing task	50 Hz		
	Cognitive functions		**Cognitive functions**	
	Increase of: • valence of emotionally negative faces perception	1 Hz	• **Lowering** sense of effort	5 Hz
	Decrease of: • valence of emotionally positive perception	1 Hz		
	• phasic alertness	1 Hz		
	• the reward perception	50 Hz		
Pre-SMA	**Motor control**		**Motor control**	
	Increase of success in : •motor inhibition task performance	1 Hz	•**Increase** of success in motor inhibition task performance	10 Hz
	Decrease of success in : • motor inhibition task performance	50 Hz		
			Cognitive functions	
	• sequence learning task performance	1 Hz	**Disturbance** of happy faces recognition	10 Hz

Рис. 2. Table 1: Representation of the SMA inhibitory and excitatory rTMS significant effects on motor and cognitive functions in healthy volunteers

Effects of neuromodulation in patients

		Inhibitory rTMS	Excitatory rTMS
SMA	**PD**	**Reduce:** • L-dopa-induced dyskinesia • L-dopa-induced dystonia • Other hyperkinetic symptoms	**Reduce:** • PD symptoms (not specified); • Freezing of gait; • Bradykinesia; • Mirror movements reduction. **Improvement in:** • Self-initiated movements; • Handwriting.
	OCD	OCD symptoms reduction	Was not applied
	TS	Tics reduction	Was not applied
	Other	**ASD:** increased movement preparation abilities in patients; **UCPPS:** decrease pelvic floor muscle tone; **PLP:** pain reduction; **MM:** mirror movements inducing.	**UCPPS:** increase pelvic floor muscle tone; **BAF:** lowering of seizure threshold for ECT
Pre-SMA	**OCD**	OCD symptoms reduction	Was not applied
	Other	Essential tremor reduction	Restless leg symptom reduction

PD – Parkinson's disease; OCD – obsessive-compulsive disorder; TS – Tourette's syndrome; ASD – Autism spectrum disorder; UCPPS: Urologic chronic pain syndrome; PLP – Phantom limb pain; MM – Mirror movements; BAF – Bipolar affective disorder; ECT – electroconvulsive therapy

Рис. 3. Table 2: Representation of the SMA inhibitory and excitatory rTMS significant therapeutical effects in patients with different nosologies