Normalizing biased spatial attention with parietal rTMS in a patient with focal hand dystonia

Normalizing Biased Spatial Attention With Parietal rTMS in a Patient With Focal Hand Dystonia

Dear Editor,

We report the following case to highlight the possible relevance of biased spatial attention in focal hand dystonia (FHD). Deficient sensorimotor inhibition is a prominent pathophysiological feature of FHD [1,2]. Low-frequency repetitive Trascranial Magnetic Stimulation (rTMS) over contralateral premotor cortex (PMC) can reinforce cortical inhibition and improve motor performance and dystonic symptoms in some patients [3,4]. Here we report the case of a 41-year-old right-handed man (23 years of education) with severe task-dependent FHD, affecting the right hand index and middle fingers. FHD had started five years before presentation and was initially associated with an increased use of the computer mouse. At the time of the study, he could not hold the pen correctly during handwriting nor perform any fine hand movement. He also presented with tremors at rest, overflow, and mirror dystonia [2]. The patient attributed a significant part of his motor problems to inability to 'disengage his thoughts' from the dystonic hand. He stated that he performed better with the affected hand, when he managed to not 'think about it.' The patient's observations prompted us to explore the possibility that hyper-attention toward the side of the affected hand might play a role in his disorder. We first tested whether the patient would show a rightward bias in visuospatial attention. Then we investigated whether suppression of left posterior parietal cortex (PPC) through inhibitory rTMS could attenuate the attentional bias and hereby alleviate dystonic symptoms. Indeed, inhibitory rTMS over left PPC improves attentional deficits in post-stroke patients presenting with biased spatial attention [5–7].

Attentional bias was assessed by asking the patient to mark the middle of ten 18 cm long horizontal lines. Handwriting was evaluated on signature and a 4 words copying task. He rated perceived symptom change on handwriting, with respect to the most recent evaluation, on a 7 points Lickert scale (-3 = significant worsening, 0 = no change, 3 = significant improvement). The patient was also asked to show how to use a stapler (Task 1), toothbrush (Task 2), a cup (Task 3) and a bottle (Task 4). Handwriting and object use were video-taped and offline evaluated on a 10 points scale (0 = unable to perform the task, 10 = normal performance) by an experimenter blind to the condition. The patient also performed a Finger Tapping Task (FTT) with the right and then left hand. He had to press two contiguous keys of the computer key-board with his index and middle finger in alternating order, as quickly and accurately as possible for 30 s. Mirror dystonia was assessed by videotaping the right hand during FTT with the left hand and offline evaluated on a 5 points scale (0 = no dystonia; 5 = maximal dystonia) by an experimenter blind to the condition. Three sessions of 1 Hz rTMS (600 stimuli per session) were applied at 90% of resting motor threshold [8] over left PPC every other day, using a 70 mm figure-of-eight coil and the MagStim Super Rapid stimulator (Magstim Company Ltd., Whitland, UK). A single-pulse TMS hunting procedure, using a PC-based line-length estimation task [9], was employed to functionally localize the PPC site. A nine points grid (3×3 cm) was centered over P3 and 10 stimuli were delivered at each location. The spot where TMS reversed the rightward bias in the majority of trials was found to be 1 cm anterior to P3. Clinical and behavioral evaluation was performed one week before intervention (pre 1), before rTMS on Day 1 (pre 2), after rTMS on Day 3 (post), and one week after intervention (follow-up, FU). A reduced protocol was used for pre and post-stimulation evaluation on Day 2 and pre-stimulation evaluation on Day 3. It did not include line bisection and object use and the patient had to copy only two words. The patient signed a written informed consent to participate to the study, which was approved by the Local Ethical Committee. He was free from medications.

Results are reported in Table 1. The rightward bisection bias was abolished after PPC stimulation as indexed by significant differences (Wilcoxon test with Bonferroni correction, $P = 0.05$) between pre 1 and post ($P = 0.007$), pre 2 and post ($P = 0.005$), and pre 1 and FU ($P = 0.008$) conditions. For handwriting, the patient received the highest performance score at baseline of Day 3 that was partly maintained at FU. On the Lickert scale, the patient did not appreciate

Table 1
Clinical and behavioral evaluation and resting motor threshold.

	LB		Lickert scale (−3 = sign. worsening, +3 = sign. improvement)		Handwriting (0 = unable to perform, 10 = normal performance)				Use of object (0 = unable to perform, 10 = normal performance)				Mirror dystonia (0 = no dyst., 5 = max dyst.)		FTT (right hand RT)		RMT	
					Signature		Word copy		Task 1	Task 2	Task 3	Task 4						
	Pre	Post	Pre	Post	Pre	Post	Pre	Post					Pre	Post	Pre	Post	LH	RH
Pre 1	+2.85 (1.83)	–	–	5	–	4	–	2	2	5	4	3	–	586 (434)	–	32%	42%	
Day 1	+1.65 (0.82)	+2	–	5	–	5	–	3	1	5	5	3	–	599 (376)	–	32%	43%	
Day 2	–	−1	+1	3	6	3	6	–	–	–	–	3	2	682 (460)	514 (312)	31%	–	
Day 3	−0.05 (1.55)	0	+1	8	7	7	7	5	3	4	3	1	2	493 (308)	425 (305)	32%	43%	
FU	+0.40 (2.01)	–	−0.5	–	7	–	6	3	3	6	6	–	2	–	615 (422)	31%	43%	

Results for line bisection (LB), Lickert self-evaluation scale (sign. worsening = significant worsening, sign. improvement = significant improvement), handwriting, use of objects (Task 1 = stapler, Task 2 = toothbrush, Task 3 = cup of coffee, Task 4 = bottle of water), and mirror dystonia (no dyst. = no dystonia; max dyst. = maximal dystonia). Values of left (LH) and right (RH) hemisphere resting motor threshold (RMT) are also reported. LB: mean bisection bias (mm) and relative standard deviation are reported for each experimental condition; positive values indicate rightward bisection bias and negative values leftward bisection bias. Pre = pre-rTMS evaluation; Post = post-rTMS evaluation; Pre 1 = 1-week pre-intervention evaluation; Day 1 = first day of rTMS application, Day 2 = second day of application, Day 3 = third day of application; FU = 1-week follow-up evaluation.

this improvement, while reporting enhanced performance from pre 1 to pre 2, when no objective change in writing performance was observed. Regarding object use, he showed higher scores at post-intervention on Tasks 1 and 2 relative to pre-treatment levels. Consistent with handwriting, mirror dystonia was scored lowest at baseline of Day 3. On the FTT, Reaction Times of the dystonic hand were ($P < 0.0001$) faster (Wilcoxon with Bonferroni correction) for post-stimulation of Day 3 than baseline of Day 1 conditions.

Discussion

Focal 1 Hz rTMS of left PPC abolished the patient's rightward attentional bias, in line with studies in post-stroke patients [5,6]. Normalization of attentional bias was associated with improvement of dystonic symptoms, suggesting that hyper-attention toward the side of the dystonic hand contributed to the patient's FHD. Given the tight link between PPC and PMC during intentional movement, it is likely that maladaptive plasticity, during the use of the dystonic hand, does not spare the PPC, leading to pathological increase of contralateral attention. Thus, PPC may represent a remote target site for stimulation to restore not only biased attention but also deficient premotor inhibition that has been implicated in the pathophysiology of FHD. Indeed, single-pulse TMS over PPC decreases the activity of parieto-frontal areas during modulation of visuospatial attention [9]. Lastly, the discrepancy between self-evaluation scores and handwriting performance highlights the importance of a possible dissociation between the objective reduction in FHD and subjective awareness of symptom amelioration in rTMS studies investigating patients with altered activity of premotor areas, underlying motor awareness [10]. The presence of biased spatial attention might offer a rationale for rTMS treatment over PPC in FHD. The role of attentional bias in FHD and the potential of rTMS over contralateral PPC or other interventions apt to rehabilitate attention warrant further investigation in prospective placebo-controlled trials.

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