Turk J Phys Med Rehab 2024;70(3):397-401
DOI: 10.5606/tftrd.2024.13022
Available online at www.turkishjournalpmr.com

Case Report

Effect of low-frequency repetitive magnetic transcranial stimulation in hemichorea-hemiballismus with ipsilateral basal ganglia hemorrhage: A case report

Kim Heejae

Department of Rehabilitation Medicine, Shihwa Medical Center, Gyeonggi-do, Republic of Korea

ABSTRACT

Post-stroke hemichorea-hemiballismus (HCHB) typically manifests as hyperkinetic movements contralateral to the lesion, but rarely occurs ipsilaterally. In this article, we present a rare case who initially presented with left hemiparesis and developed right HCHB after right basal ganglia hemorrhage. To facilitate motor recovery in the left hemiparesis, we applied low-frequency repetitive transcranial magnetic stimulation (rTMS) over the left primary motor cortex. Unexpectedly, the right HCHB was significantly reduced after four weeks of therapy. Post-treatment perfusion imaging showed increased cerebral blood flow in the left middle cerebral artery territory. In conclusion, low-frequency rTMS may be considered an alternative therapy for post-stroke HCHB.

Keywords: Basal ganglia, chorea, dyskinesias, movement disorders, stroke, transcranial magnetic stimulation.

Hemichorea-hemiballismus (HCHB) is a rare hyperkinetic movement disorder characterized by persistent and irregular involuntary movements of the unilateral proximal and distal extremities. The prevalence of post-stroke HCHB is reportedly 0.54%,[1] with a small number of cases reporting HCHB ipsilateral to the lesion.[2,3] Conventional therapeutic interventions for HCHB are limited by their low efficacy and potential for unpredictable adverse effects. Repetitive transcranial magnetic stimulation (rTMS) is a widely used, non-invasive brain stimulation technique for motor recovery after stroke.

In this article, we describe the first case of successful treatment with rTMS in a patient with HCHB after ipsilateral basal ganglia injury.

CASE REPORT

A 66-year-old male patient was admitted to our hospital with abrupt-onset left hemiparesis. The patient had a history of hypertension and dyslipidemia, but no family history of chorea or ballism and no surgical history. Brain and neck computed tomography (CT) angiography revealed a hypodense lesion in the right middle cerebral artery (MCA) territory (Figure 1a) and occlusion of the right internal carotid artery (ICA) (Figure 1b). Complete recanalization was achieved immediately, but 8 h after the procedure, the patient gradually lost his consciousness and responded only to painful stimuli. Cranial CT showed a large hemorrhage in the right basal ganglia, extending into the lateral third and fourth ventricles. Consequently, the brain parenchyma was compressed with an extensive midline shift (Figure 1c). Craniectomy and hematoma evacuation were performed, and subsequent cranial magnetic resonance imaging (MRI) revealed no evidence of stroke in the left hemisphere. Two days later, the patient developed involuntary and irregular movements of the right limbs (Supplementary Video 1), which worsened under mental stress and were absent during sleep. Brain imaging was performed to differentiate recurrent

Corresponding author: Kim Heejae, MD. Department of Rehabilitation Medicine, Shihwa Medical Center, Gyeonggi-do, 15034 Republic of Korea.
E-mail: hjkimrehab@gmail.com

Received: May 03, 2023 **Accepted:** October 02, 2023 **Published online:** August 26, 2024

Cite this article as: Heejae K. Effect of low-frequency repetitive magnetic transcranial stimulation in hemichorea- hemiballismus with ipsilateral basal ganglia hemorrhage: A case report. Turk J Phys Med Rehab 2024;70(3):397-401. doi: 10.5606/tftrd.2024.13022.

stroke or development of new lesions, but there were no significant changes. Antipsychotics (i.e., haloperidol, aripiprazole, and quetiapine) and clonazepam were used to alleviate choreatic movements, but were not effective. Three months after the onset of stroke, the patient was transferred to our clinic, and cranial MRI was performed. No ischemic or hemorrhagic lesions were observed in the left cerebral hemisphere (Figure 1d). On physical examination, his muscle strength was Grade 2 in the left upper and lower extremities and Grade 5 in the right upper and lower extremities. Choreatic movements of the right side were still present, and the frequency was irregular, but usually 40 to 60 times/min while awake. To promote motor and functional recovery of left hemiparesis, we planned low-frequency rTMS application. It was delivered to the left primary motor cortex (M1) to suppress cortical hyperexcitability and, thus, reduce interhemispheric inhibition. The rTMS was applied at 1 Hz (90% of the resting motor threshold) for

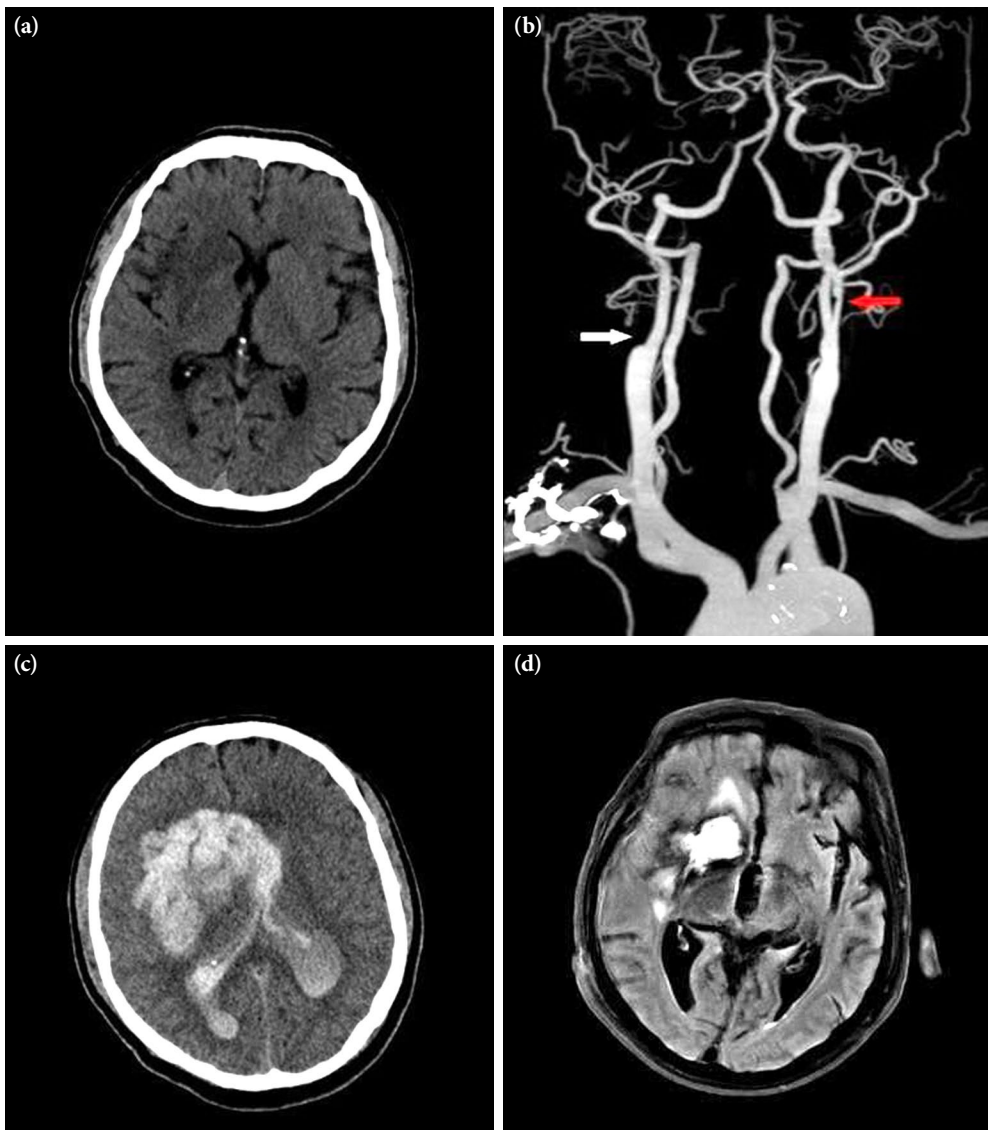


Figure 1. CT and MRI, angiography of the brain. **(a)** Cranial CT showing low density signals in the right basal ganglia and frontal lobe. **(b)** CT angiography revealed occlusion of the right ICA (white arrow) and stenosis of left proximal ICA (red arrow) **(c)** Cranial CT demonstrated a large right basal ganglia hematoma with intraventricular extension and midline shifting. **(d)** T2 FLAIR MRI of the brain three months after the stroke.
CT: Computed tomography; MRI: Magnetic resonance image; ICA: Internal carotid artery; FLAIR: Fluid-attenuated inversion recovery

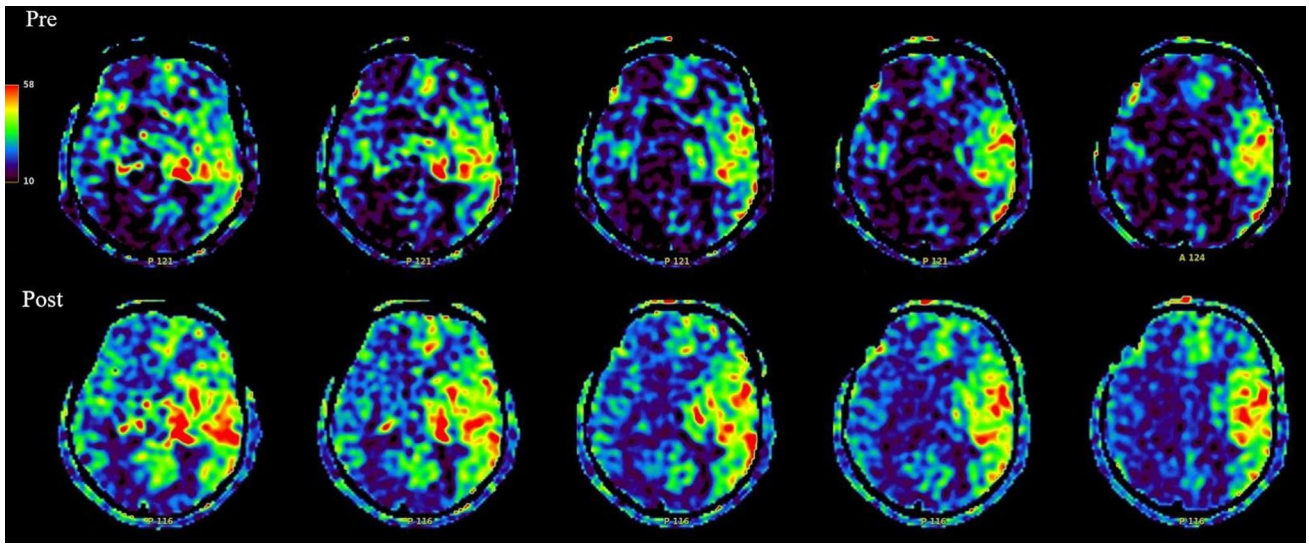


Figure 2. Color-coded cerebral blood flow maps generated based on arterial spin-labelled images. The pretreatment images show a small area of hyperperfusion (yellow-red region) appearing in the left middle cerebral artery territory, including thalamus and basal ganglia, primary motor cortex, and premotor cortex, which becomes larger and more pronounced after low-frequency repetitive magnetic transcranial stimulation.

1,600 pulses per session. Treatment continued at a session per day, five days per week, for a total of four weeks. Conventional rehabilitation was started immediately after surgery and continued throughout the intervention. Two weeks after the start of rTMS, the involuntary movements of the right limbs unexpectedly began to decrease (20 to 30 times/min), and by Week 4, the frequency and amplitude of choreatic movements were significantly reduced (5 to 10 times/min) (Supplementary Video 2). Functionally, this allowed him to use a spoon with his right hand and sit independently for more than 5 min. A follow-up perfusion MRI was performed, which showed relatively increased cerebral blood flow (CBF) in the left MCA territory, including the thalamus, basal ganglia, and motor cortex, compared to that before treatment (Figure 2). Six months later, the symptoms resolved. There were no adverse and unanticipated events associated with the therapeutic interventions.

DISCUSSION

Post-stroke HCHB is a rare hyperkinetic movement disorder which is most commonly associated with the striatum and thalamus. The most widely accepted pathogenesis of HCHB is related to the disruption of the excitatory and inhibitory signal balance between the basal ganglia and cerebral cortex, which are connected by direct and indirect pathways.[4] Ischemic injury to the basal ganglia leads to disruption of the indirect striatal pathway, which causes decreased activity of the subthalamopallidal pathway. Furthermore, it decreases the inhibitory activity of the γ-aminobutyric acid (GABA)-ergic pallidothalamic tract, which increases the excitatory activity of glutamatergic projections in the thalamocortical and thalamostriatal pathways. Increased activity in the premotor and motor cortices affects the excitatory pyramidal tract, eventually leading to contralateral HCHB.[4]

To date, several mechanisms underlying ipsilateral HCHB have been proposed. In our case, a plausible hypothesis is that the space-occupying lesion induced ipsilateral hyperkinetic movement by stimulating associated structures in the contralateral hemisphere.[5] As the unaffected basal ganglia/thalamus was compressed due to a large basal ganglia hematoma with midline shifting, the vascular flow to the basal nuclei and thalamus, which was already reduced to a near-critical level by proximal ICA stenosis, may have been further reduced. This may have affected the basal ganglia circuit, specifically interfering with the premotor and motor cortical control of the striatum and its thalamic connections, resulting in ipsilateral HCHB.[4,5]

The non-invasive rTMS method can modulate cortical excitability and has been widely used as a complementary treatment to promote motor

recovery after stroke. Low-frequency rTMS to M1 of the unaffected hemisphere has shown to reduces ipsilateral cortical excitability and increase the excitability of the affected motor cortex. This stimulation normalizes imbalanced interhemispheric inhibition by suppressing over-inhibition from the unaffected M1 to the affected M1. The effectiveness of rTMS in post-stroke hemichorea has been reported; however, this study was for contralesional hemichorea, and the therapeutic mechanism remained unclear.[6] We demonstrated a decrease in HCHB contralateral to the stimulation and an increase in the cortical-subcortical CBF in the ipsilateral cerebral hemisphere after low-frequency rTMS. This may be related to the regional and remote neural modulation effects of low-frequency rTMS on CBF in brain areas. The regional effect is induced by the direct excitation of stimulated cortical neurons with electrical currents.[7] Mesquita et al.[8] reported increased CBF and metabolism in the ipsilateral motor cortex after 1 Hz rTMS (95% of the resting motor threshold), reflecting increased activity of inhibitory interneurons in the stimulated motor cortex; thus, low-frequency rTMS can selectively stimulate inhibitory interneurons, leading to the reduction of contralateral hemichorea by suppressing hyperexcitation of the motor cortex ipsilateral to stimulation. On the contrary, remote effects are mediated by interregional functional connectivity.[7] Chouinard et al.[9] applied 1-Hz rTMS to M1 for 15 min and compared CBF changes before and after treatment. They observed a significant increase in the ipsilateral putamen, suggesting that it was related to corticostriatal projections. Wang et al.[10] found that 1 Hz rTMS to M1 resulted in significantly increased neural activity in the basal ganglia. These results also indicate that the modulatory effect of low-frequency rTMS is transmitted from the superficial cortex to deep brain areas through functional connectivity. Therefore, we speculate that changes in the cortical-subcortical CBF after low-frequency rTMS may have contributed to the reduction in HCHB by altering corticostriatal network activity and affecting the associated basal ganglia-thalamocortical circuits. However, this explanation is based on only a single case report; further well-designed studies are needed to confirm the efficacy of rTMS and elucidate its therapeutic mechanisms in the treatment of HCHB.

In conclusion, we describe a case of right basal ganglia hemorrhagic transformation after MCA territory infarction combined with ipsilateral HCHB. Low-frequency rTMS over the unaffected hemisphere effectively reduced HCHB on the affected side. This improvement was probably due to the regional and remote neural modulation effects of low-frequency rTMS. Nonetheless, further studies are needed to confirm the efficacy of rTMS and clarify its therapeutic mechanisms in HCHB treatment.

Acknowledgments: The author would like to thank the participant in this study.

Patient Consent for Publication: A written informed consent was obtained from the patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interest: The author declared no conflicts of interest with respect to the authorship and/or publication of this article.

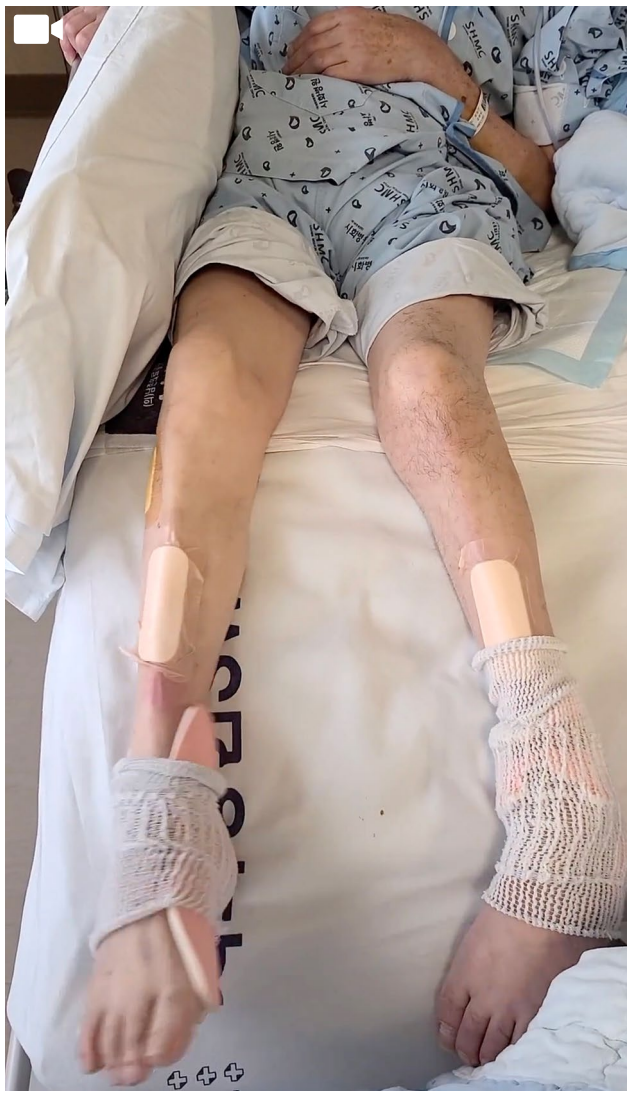
Funding: This study was supported by Shihwa Medical Center research fund.

REFERENCES

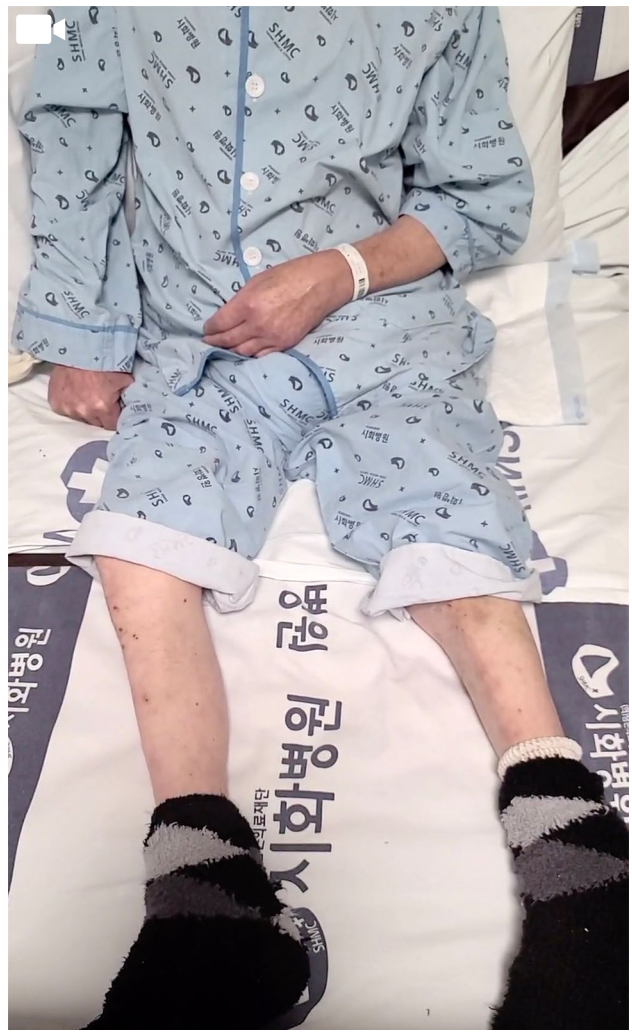
1. Chung SJ, Im JH, Lee MC, Kim JS. Hemichorea after stroke: Clinical-radiological correlation. J Neurol 2004;251:725-9. doi: 10.1007/s00415-004-0412-5.
2. Li ZS, Fang JJ, Xiang XH, Zhao GH. Hemichorea due to ipsilateral thalamic infarction: A case report. World J Clin Cases 2021;9:5287-93. doi: 10.12998/wjcc.v9.i19.5287.
3. Wei J, Zhang Y. Hemichorea in a patient with ipsilateral cortical infarction: A case report. BMC Neurol 2021;21:420. doi: 10.1186/s12883-021-02420-4.
4. Xian WB, Zhang XS, Shi XC, Luo GH, Yi C, Pei Z. Corticostriatal hypermetabolism in moyamoya disease-induced hemichorea: Two case reports and a literature review. Front Neurol 2021;12:649014. doi: 10.3389/fneur.2021.649014.
5. Inoue H, Yamamura R, Yamada K, Hamasaki T, Inoue N, Mukasa A. Hemichorea induced by a sphenoid ridge meningioma. Surg Neurol Int 2021;12:201. doi: 10.25259/SNI_171_2021.
6. Di Lazzaro V, Dileone M, Pilato F, Contarino MF, Musumeci G, Bentivoglio AR, et al. Repetitive transcranial magnetic stimulation of the motor cortex for hemichorea. J Neurol Neurosurg Psychiatry 2006;77:1095-7. doi: 10.1136/jnnp.2005.082875.
7. Siebner HR, Takano B, Peinemann A, Schwaiger M, Conrad B, Drzezga A. Continuous transcranial magnetic stimulation during positron emission tomography: A suitable tool for imaging regional excitability of the human cortex. Neuroimage 2001;14:883-90. doi: 10.1006/nimg.2001.0889.
8. Mesquita RC, Faseyitan OK, Turkeltaub PE, Buckley EM, Thomas A, Kim MN, et al. Blood flow and oxygenation changes due to low-frequency repetitive transcranial magnetic stimulation of the cerebral cortex. J Biomed Opt 2013;18:067006. doi: 10.1117/1.JBO.18.6.067006.

9. Chouinard PA, Van Der Werf YD, Leonard G, Paus T. Modulating neural networks with transcranial magnetic stimulation applied over the dorsal premotor and primary motor cortices. J Neurophysiol 2003;90:1071-83. doi: 10.1152/jn.01105.2002.

10. Wang J, Deng XP, Hu YS, Yue J, Ge Q, Li XL, et al. Low-frequency rTMS targeting individual self-initiated finger-tapping task activation modulates the amplitude of local neural activity in the putamen. Hum Brain Mapp 2023;44:203-17. doi: 10.1002/hbm.26045.



Supplementary Video 1. Pretreatment video showing right hemichorea-hemiballismus (HCHB) and left hemiparesis.



Supplementary Video 2. Significant reduction in the frequency and amplitude of right hemichorea-hemiballismus (HCHB) after 4 weeks of repetitive magnetic transcranial stimulation (rTMS).