Bilateral cerebellar repetitive transcranial magnetic stimulation for chronic nonlateralized ataxia after hemorrhagic stroke: A case report

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Abstract

There are insufficient treatment options available for recovery related to cerebellar ataxia. Limited data using repetitive Transcranial Magnetic Stimulation (rTMS) have demonstrated reduction of symptom burden, though associated with nonuniform cerebellar ataxia etiologies and differing rTMS treatment protocols. Additionally, there are no available data for use of rTMS in individuals suffering from bilateral stroke-related symptoms. We present the case of a patient with chronic cerebellar ataxia following a hemorrhagic stroke who underwent inhibitory rTMS to bilateral cerebellar targets with demonstrated improvement in symptoms.

Introduction

Cerebellar ataxia can arise from several etiologies, including posterior circulation stroke syndromes [1]. There are limited treatment options to support functional recovery [2]. A small number of clinical trials have demonstrated that repetitive Transcranial Magnetic Stimulation (rTMS) has some efficacy for reducing symptom burden in patients with cerebellar ataxia with differing etiologies, using varying treatment protocols [3]. In studies exploring post-stroke syndromes specifically, rTMS using 1 Hz stimulation targeting the ipsilateral cerebellar hemisphere has been shown to significantly improve ataxia as measured by the 10-meter walk test (10MWT), Berg Balance Scale (BBS), or Timed Up and Go test (TUG) [4–6]. However, no data thus far have demonstrated improvement with rTMS treatment for bilateral post-stoke cerebellar ataxia. We present the case of a patient with chronic cerebellar ataxia following a cerebellar hemorrhage in the setting of an arteriovenous malformation (AVM) who received 1 Hz rTMS to bilateral cerebellar targets and showed improvement in ataxia.

Case

A 58-year-old man with a history of hyperlipidemia was in his usual state of health when he experienced a sudden cerebellar hemorrhage. At that time, he underwent a suboccipital craniotomy with resection of left cerebellar hematoma and subdural hematoma with C1 laminectomy and pericranial patch graft of the dura. His intensive care course was substantial, necessitating a right frontal ventriculostomy, tracheostomy, and percutaneous endoscopic gastrostomy (PEG) tube placement. After approximately three to four weeks, the patient made a significant recovery, with removal of tracheostomy and eventual transfer to a rehabilitation facility. The patient had lingering symptoms including nausea, vomiting, diplopia, muscle spasticity, gait instability, and urinary incontinence. Over several years of intensive treatment including physical therapy, many of these symptoms improved aside from ataxia and urinary incontinence. The latter symptom eventually improved with implantation of a neurostimulator, but significant ataxia remained.

Approximately 12 years after the original injury, the patient presented for consultation regarding rTMS treatment. His primary complaints were slow and unsteady gait, as well as bilateral difficulties with balance and stability (i.e., he did not favor one side). The patient ambulated with a walker for stability

and reported that he could walk limited distances. Upon physical examination, he demonstrated a slow wide-based gait, was not able to rise from sitting unaided, and was unable to bend over to pick up a pencil from the floor. His baseline 10MWT demonstrated a speed of 0.57 meters per second using a rolling walker for stability. His baseline BBS was 27.

Given the patient's report of symptoms and demonstrated signs of nonlateralized ataxia on exam, the decision was made to treat with bilateral stimulation. A Siemens 3T scanner was used to obtain a high-resolution T1-weighted brain Magnetic Resonance Imaging (MRI) scan, which showed midline cerebellar gliosis and atrophy much greater on the left. Three-dimensional image reconstruction for neuronavigation was performed using a Brainsight system (Rogue Research, Montreal, Canada) that was then used to guide stimulation, which was administered with a Magventure X100 stimulator equipped with a B-70 coil (Magventure, Denmark). The patient underwent five daily sessions of 1 Hz for 900 pulses at 100 percent motor threshold (MT), based on a prior studied protocol [4]. Stimulation was delivered sequentially to the right followed by the left cerebellar hemispheric targets (Fig. 1). The patient tolerated the sessions without incident and reported no side effects. He reported subjective improvement after two days of stimulation. After the fifth day of treatment, his 10MWT had improved to 0.60 meters per second and BBS to 38. The patient was able to rise from sitting unaided and was able to bend to pick up a pencil from the floor easily. He reported improved balance and stability in that he could stand unaided and without using hand supports while performing activities of daily living (ADLs) in the bathroom (e.g., to shower and shave), which he was unable to do prior to treatment.

Discussion

This is the first reported case to our knowledge using bilateral cerebellar 1 Hz rTMS to treat post-stroke cerebellar ataxia. Typically, when cerebellar ataxia is caused by stroke, 1 Hz or inhibitory stimulation is used to target the ipsilateral cerebellar hemisphere as deficits are often lateralizing. However, in this case, the patient demonstrated negligible lateralization and subjectively reported his symptoms were equivalent bilaterally.

Though there are limited data overall for use of rTMS for cerebellar ataxia, there appears to be growing evidence for effect differences related to specific etiology. In a recent systematic review of clinical trials using rTMS with varying cerebellar etiologies of ataxia, subgroup analysis demonstrated that effect of rTMS differed significantly with etiology [3]. This suggests that the development of treatment protocols may need to be tailored specifically to pathology rather than ataxia as a symptom in general.

For stroke-related cerebellar ataxia, it appears that 1 Hz stimulation targeting the ipsilateral cerebellar hemisphere has shown the most benefit in the literature thus far. However, bilateral stimulation may also be worth exploring further given the case presented here. Bilateral stimulation has been explored in other stroke-related symptoms, such as post-stroke dysphagia [7], as well as other etiologies of cerebellar ataxia including multiple system atrophy [8]. Our case suggests that bilateral stimulation may be beneficial for post-stroke cerebellar ataxia even more than a decade after injury, but further work should

be conducted to evaluate clinical benefits, durability, and underlying neural mechanism particularly for lateralizing syndromes.

Declarations

Declaration of interests: None.

Ethical Approval

Patient provided consent to publish. IRB not applicable.

Competing Interests

The authors have no competing interests.

Authors' contributions

E.E. and A.L. wrote the main manuscript text. E.E., M.L. and C.M. were involving in post-treatment scales and assessments of the patient. J.C. was involved in preparing the figure and figure caption. D.N., N.V-C., B.R. J.C., and C.C. were involved in preparing the treatment protocol and targeting for the patient. A.S., S.W., N.G., T.S., and A.L. were directly involving in administering the treatment to the patient throughout the treatment course. All authors additionally reviewed and revised the manuscript.

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Figures

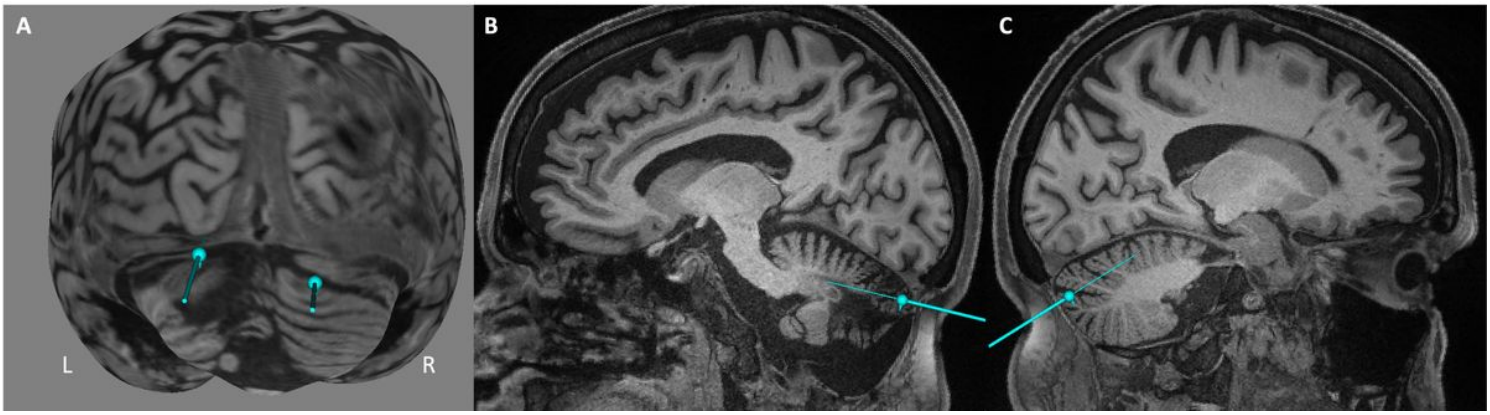

Figure 1

Neuronavigation targets. A. Posterior view of the two targets. Both trajectories were defined to minimize scalp-to-cortex distance and optimized with respect to placement on the scalp. Coil handle was pointing in the superior direction. B. Left cerebellar target was 2 cm laterally from the midline and approximately 1 cm below the inion. This adjustment to the original approach [4] was made due to the extensive cerebellar damage. C. Right cerebellar target was 2 cm laterally from the midline and 2 cm below the inion, following the approach described in Kim et al [4].