

Transcranial Magnetic Stimulation in Spastic Cerebral Palsy Helps Achieve Developmental Milestone: A Case Report

Meena Gupta¹, Bablu Lal Rajak¹, Dinesh Bhatia^{1*} and Arun Mukherjee²

¹Department of Biomedical Engineering North Eastern Hill University, India

²UDAAN – For the Disabled New Delhi, India

Corresponding author: Dr. Dinesh Bhatia, Department of Biomedical Engineering North Eastern Hill University, Shillong Meghalaya, India, Tel: +91 0364-2721777; E-mail: bhatiadinesh@rediffmail.com

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Abstract

Developmental disability in a growing child limits the attainment of certain functions such as motor, communication, perpetual and cognitive skills. Cerebral Palsy (CP) is one such developmental disability that hinders the movement and activities of daily living of the affected child. In order to treat this disorder, several interventional tools are available which has its own pros and cons. Repetitive Transcranial magnetic stimulation (rTMS) is a new noninvasive tool employed for the treatment of CP due to its neuromodulatory effect that facilitates motor memory formation, motor performance and motor learning in individuals. In this report, a promising effect of rTMS therapy is discussed wherein a wheelchair ridden patient was able to crawl, kneel and move after two rounds of treatment procedure.

Keywords: Cerebral palsy; Physical therapy; Repetitive transcranial magnetic stimulation; spasticity

Introduction

Development of a growing child is an important process that follows after birth such as smiling, babbling, waving, etc. that ensures proper growth and future welfare of a child. Development occurs in five domains: physical such as fine and gross motor skill, communication such as receptive and adaptive; language skill; perceptual skills such as senses of smell, auditory visual and taste; social skill such as identification of parent and adjustment in peer group and cognitive skills such as understanding and meaningful interpretation of sensory information [1]. All these domains are spontaneous phenomenon in a normal growing child but the onset of each is time dependent. If a child has not attained a certain developmental skill by a certain age, then they are at increased risk for a developmental disability [2]. Cerebral Palsy (CP) is one such developmental disability that is found in children which occurs due to birth complication or injury to the developing

brain [3]. As a result of the brain injury, a child is not able to perform activities of daily living and possesses limited movement due to spasticity in the muscles. Muscle spasticity in CP is a major cause that limits the physical functional movement of the joints [4]. It is known that relieving muscle spasticity can improve functional performances of the affected patients that help achieve developmental milestone. Hence, a number of interventional approaches are employed such as passive stretching through physical therapy (PT), rhizotomy, muscle relaxant medication, etc., to reduce muscle spasticity but none of these treatment approaches were able to give desired results in limited time span. In a quest to find an interventional tool for CP patients we found that application of repetitive Transcranial magnetic stimulation (rTMS) combined with PT demonstrated some promising results towards gain in functional motor activity [5,6] with reduction in muscle spasticity in CP patients [7]. The case report presented here is one such amazing experience while working with spastic CP children by employing rTMS.

Case Presentation

A 13 year old girl child was diagnosed as a case of spastic quadriplegic cerebral palsy at an age of 2. According to her medical reports and positron emission tomography (PET) scan it was found that her motor cortex area of the brain was severely damaged. Surprisingly, her cognitive functions such as speech and memory were not affected and she was able to understand, communicate and speak normally. According to her birth history she was an unplanned child, with birth weight less than 2.5 kg and at the time of birth she delayed in crying, thus several birth complications were observed by medical staff present during her birth. Additionally, she also had a history of frequent seizures till the age of three but it improved with medication and by 5 years she was completely free from such attacks. Out of four sisters and one brother, all siblings were normal; she was the only one affected with CP. As reported by her sisters, she was able to walk with support when she was 7 years old which must be a combined effect of muscle relaxant medications such as beclofenic sodium and botox along with routine physical therapy that was provided to her. After the death of her mother, she was

neglected and no proper treatment was given to her leading to discontinuation of her medication and physical therapy. The negligence pushed her towards the development of deformity in knee flexion, contracture in lower limb bilaterally and elbow flexion contracture in upper limb. She also developed swan neck deformity in carpals and metacarpal bone and claw, hand deformity in wrist joint. All these deformities and contractures moved her towards physical dependency in performing any physical movement independently.

She was brought to our centre for therapy at an age of 13 in such a condition that she was not able to crawl or sit independently. She had severe contractures and deformity at elbow, knee and ankle joints bilaterally due to which she was unable to perform any useful physical activity. The doctor at the centre after knowing her history of medication and therapy advised physical therapy for a month to observe changes in her physical activity without any medication. There was mild change in her muscle stiffness which was not satisfactory; then the doctor advised rTMS along with PT. This choice of treatment plan was made observing the benefits of rTMS on CP patients for the past one year.

Prior to start of the rTMS therapy, her physical assessment using modified Ashworth scale (MAS) for muscle spasticity, gross motor function measure (GMFM) and gross motor function classification system (GMFCS) for developmental milestone, pre-assessed data was recorded. First round of rTMS therapy began by stimulating her motor cortex area of the brain with frequency of 10Hz and 2500 pulse train for 15 minutes daily for 20 days (5 days a week for 4 weeks) followed by PT of 30 minutes duration daily for 20 days. After completion of 20 sessions, post assessment of GMFM and GMFCS was performed and data recorded. Second round of rTMS therapy was started after two months of the previous therapy to evaluate the longevity of effect of rTMS in this patient. Similar assessment and therapy regime was performed in this round too. After completion of the second round, the recorded data was analyzed to demonstrate rTMS effect.

Results

The pre and post assessment scores (in %) of GMFM of both the rounds is represented in **Table 1**. After completion of first round of rTMS therapy, remarkable reduction in muscle tightness in this patient was observed and the changes between pre versus post GMFM score represented as functional motor gain was found to be 20.60%.

In the first round 21.57%, 43.33% and 38.09% changes in pre versus post GMFM score was observed in three GMFM domains I, II and III respectively demonstrating that the patient was able to freely perform rolling function and to a good extent sitting and crawling. Additionally, total functional gain of 8.38% was observed after completion of second round of therapy due to improvement in GMFM domains II (15%), III (16.67%) and IV (10.24%). Here it can be noted that just after two (2) months of rTMS therapy combined with PT, this patient was able to regain her motor function that was present when she was 7 years old. The effect of rTMS on this patient was very encouraging as we

could see a patient that came to the centre in an unmovable condition can now crawl from place to place, kneel and even walk few steps with the help of a support.

Table 1: Gross motor functional measure (%) of first and second round rTMS therapy.

GMFM Domains	Round 1		Round 2	
	Pre	Post	Pre	Post
I: Lying & rolling	78.43	100.00	100.00	100.00
II: Sitting	6.67	50.00	75.00	90.00
III: Crawling & Kneeling	0.00	38.09	54.76	71.43
IV: Standing	0.00	0.00	2.56	12.80
V: Walking & running	0.00	0.00	0.00	0.00
Total	17.02	37.62	46.46	54.85
Functional motor gain	20.60		8.38	

Discussion and Conclusion

TMS, is a noninvasive brain stimulation technique is proving to be a promising tool for neurorehabilitation for various neurologic and psychiatric conditions due to its ability to modulate cortical excitability of the motor cortex area of the brain [8,9]. Additionally, it was demonstrated that TMS stimulation of prefrontal and motor cortical areas gave rise to trans-synaptic activation of subcortical circuits which is responsible for motor activity [10] and in the management of spasticity [11]. Furthermore, the use of TMS as research tool to facilitate motor memory formation, motor performance, and motor learning in healthy volunteers raised exciting hypothesis for patients with neurologic and psychiatric disorders [12]. However, report on improvement of motor score and gait pattern with high-frequency r-TMS combined with rehabilitation therapy demonstrated its effectiveness in the management of motor impairment and spasticity than rehabilitation therapy alone [13] provides good evidences that rTMS through cortical modulation leads to increase in the neuronal activities that descends down the motor pathway for improving the muscle functions. The rapid changes observed in this patient can be due to all these effects of rTMS; where the therapy was able to restore the motor memory that was once lost after the age of 7 and add more of functional activity in the patient as the therapy continued. It is also worth reporting that this girl did not suffer any seizures during and after rTMS therapy as reported by her parents. Thus, it can be concluded that rTMS through its neuromodulatory effect is an effective and safe treatment approach for treating spastic CP patients by improving their motor activity by reducing muscle spasticity and in facilitating motor memory and learning functions.

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