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Case Report

Efficacy of Repetitive Transcranial Magnetic Stimulation on Excutive Fuction in Children with Autism Spectrum Disorders

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Abstract

Autism spectrum disorder is a neurodevelopmental disorder that imposes a serious caregiving burden on society and families. Especially for children with early detection and diagnosis of autism, more and better treatment methods are needed to improve their daily living abilities and quality of life. The existing technological means are mostly behavioral interventions, and physical factors have not been used as routine treatments. There are also few cases of transcranial magnetic therapy applied to younger ASD children. This case report describes a 4-year-old child with autism spectrum disorder who not only has developmental delays but also executive dysfunction. Therefore, he received rehabilitation treatment. He continuously received behavioral interventions and increased high-frequency repetitive transcranial magnetic therapy treatment. As a result, it was found that the developmental quotient of the children improved after treatment, especially in the hand eye coordination area and personal social area. At the same time, children's control inhibition improved, GO test accuracy increased, and reaction time shortened. However, there was no significant change in the NOGO test accuracy and reaction time. In conclusion, high frequency transcranial magnetic stimulation may improved executive function and growth and development in children with ASD. We need to conduct more controlled trials and objective evaluation methods in the future to understand the therapeutic efficacy and mechanism of transcranial magnetic therapy on executive function in children with autism.

Keywords

Repetitive Transcranial Magnetic Stimulation (rTMS), Excutive Fuction (EF), Autism Spectrum Disorders (ASD)

1. Introduction

Autism Spectrum Disorder (ASD) is a group of neurodevelopmental disorders which are more commonly noticed and diagnosed now than in the past [1, 2]. Individuals with autism have atypical cognitive deficits such as deficits in social communication and the presence of restricted, social deficits, perceptual, atypical perceptual and information processing [3]. Executive Function (EF) is a higher order cognitive function including cognitive flexibility, inhibitory control, and working memory [4]. Executive function that important developmental changes occur between the ages of 2 and 5, enables individuals to carry out purposeful behaviors in a coordinated and orderly manner through flexibility and optimization [5].

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Previous studies have shown that repetitive transcranial magnetic stimulation (rTMS), a physical factor therapy, can modulate brain activity. In particular, different stimulation patterns of rTMS lead to changes in the production of activity in targeted brain regions [6, 7]. Different developmental disorders in childhood (such as autism and attention deficit hyperactivity disorder) may cause deficits in various aspects of executive functions [8, 9]. Few studies support the potential efficacy of rTMS in the treatment of autism spectrum disordersymptoms.

2. Case Report

A 4-year-old male child who is the third child of healthy nonconsanguineous parents. His perinatal record was normal. He passed regular checkups and had no developmental or psychomotor delays in infancy. At the age of 2 years and 6 months, the child was found did not respond to calls for names and poor eye contact. He used few words to communicate with his peers, and lacked of social skills. In order to seek diagnosis and treatment, he went to the Children's Hospital. Improved the relevant assessment、electroencephalogram and Magnetic resonance imaging, he was diagnosed with autism spectrum disorder, and rehabilitation was recommended subsequntly. Then the child came to our hospital and receive treatment. After a period of behavioral treatment, the child responded to name calling, short eye contact and was able to daily communication. However, his linguistic reasoning was somewhat lacking, often engaging in self-talk, and his social skills were not as developed as those of children his own age. When facing the changes in the new environment, he takes a long time to adapt and difficult to change the game. The child exhibits stereotypical behaviors and has limited interests, such as repeatedly pushing buttons, with a particular fondness for toy cars.

3. Intervention and Evaluation

The children were subjected to behavioral intervention and repetitive transcranial magnetic stimulation with stimulation parameters of dorsolateral right prefrontal lobe, intensity 27, frequency 5 Hz for 8 weeks. Conduct GO/NO-GO test (GNGT) and Gesell Developmental Scale (GDS) before and after the trial. The go/no-go task analysis was used to evaluate the response inhibition ability of children.

4. Results

The go/no-go task analysis showed positive effects on GO accuracy and reaction time. However, no significant difference in improvements of NOGO accuracy and reaction time could be observed before and after the trial. (Table 1)

Gesell Developmental Scale showed an improvement in the child's developmental quotient, and there is also an improvement in the scores of subdomains, especially in the Hand-Eye Coordination area and Personal Social area. (Table 2)

Table 1. *Results of statistical analysis of GNGT performance measures.*

		Pre-test	Post-test
Go accuracy	Level 1	0.30	0.30
	Level 2	0.30	0.51
	Level 3	0.26	0.50
	total	0.29	0.44
No-go accuracy	Level 1	0.03	0
	Level 2	0	0.03
	Level 3	0	0.03
	total	0.01	0.02
Go response time	Level 1	0.67	0.69
	Level 2	0.65	0.57
	Level 3	0.75	0.67
	total	0.69	0.65
No-go response time	Level 1	0.80	0.80
	Level 2	0.80	0.80
	Level 3	0.80	0.80
	total	0.80	0.80

Table 2. *Results of Gesell Developmental Scale.*

	Developmental Quotient	Gross Motor	Personal Social	Force Language	Hand-Eye Coordination	Visual Expression
Pre-test	75	39.0	31.0	30.5	33.5	39.5
Post-test	90	45.0	43.5	42.0	48.0	48.0

5. Discussion

Children with autism spectrum disorders often have behavioral symptoms such as impaired attentional control, impaired information processing, difficulty shifting attention, and slow reaction time, which makes it necessary to focus on executive functioning while treating the three main symptoms [10]. The dorsolateral prefrontal cortex (DLPFC) is an important site for processing cognitive functions such as working memory, decision making, and modulation of selective attention [11, 12]. The micropost lesions in ASD patients are most pronounced in the highly sorted dorsolateral prefrontal cortex.

In this report, it can be observed that high-frequency rTMS improved the performance of controlled inhibition in children with ASD by excitation of the cortex. The results showed that rTMS increased the accuracy and response of the Go task. HF-RTMS stimulates the left DLPFC to increase active cognitive control. And this is similar to the results of previous research. Using a higher pulse frequency has been shown to safely and effectively improve depressive symptoms and cognitive function in adolescents [13], and cognitive effects of nonvasive brain stimulation at the task level in healthy cohorts have also been reported in a meta-analysis [14]. Another study investigated the effects on attentional lapses by means of a Go-NoGo test in recently alcohol detoxified subjects by stimulating the right DLPFC: a reduction in individual reaction time variability was observed, suggesting that active stimulation reduces attentional lapes [15].

In addition, the development of children, especially the Hand-Eye Coordination aspect and Personal Social aspect were more obvious. High-frequency tranca magnetic stimulation may affected metabolic activities, activation of neurotransmitting systems in the stimulating area and remote brain areas, the activation of neurotransal systems, and the connection and function of neural networks.

6. Conclusion

High frequency transcranial magnetic stimulation may improved executive function and growth and development in children with ASD. But we need to further conduct a large number of double-blind, controlled, age stratified trials, and use more objective evaluation methods, such as functional magnetic resonance imaging, to further confirm the effects and therapeutic effects of transcranial magnetic stimulation on the brain.

Abbreviations

ASD	Autism Spectrum Disorders
rTMS	Repetitive Transcranial Magnetic Stimulation
EF	Excutive Fuction
GNGT	GO/NO-GO Test
GDS	Gesell Developmental Scale
DLPFC	Dorsolateral Prefrontal Cortex

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Author Contributions

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Data Availability Statement

The data supporting the conclusions of this article will be made available by the authors on request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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