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Effectiveness of osmotic-controlled release oral delivery system methylphenidate in the treatment of stuttering that combined with attention-deficit/hyperactivity disorder: A case report

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Abstract: Attention-Deficit/Hyperactivity Disorder (ADHD) is the most common neurodevelopmental disorder in children that shows comorbidity with several psychopathology included stuttering. The prefrontal cortex is the area of brain that sends and receives projections from virtually all cortical sensory systems, motor systems, and many subcortical structures. It has been shown that psychostimulant medication increases activation of the inferior prefrontal cortex and the basal ganglia. Both functional neuroimaging and neuropsychological studies show that psychostimulant medication improves executive functions. Verbal fluency is also considered as one of the executive functions. In this article, we report osmotic-controlled release oral delivery system (OROS) methylphenidate treatment effectiveness of stuttering that combined with ADHD.

Keywords: ADHD, Stuttering, Psychostimulants, Treatment

1. Introduction

Pediatric attention-deficit/hyperactivity disorder (ADHD) is among the most common childhood-onset psychiatric disorders with a prevalence of 5.5–9.3% in the United States and 8–12% worldwide. Children and adolescents with this disorder experience educational difficulties, problems with self-esteem, significantly impaired family and peer relationships, and an overall decrease in quality of life. The extensive body of literature on the etiology of ADHD strongly suggests genes exert an influential role on the transmission, onset, and persistence of the disorder. Research places ADHD as one of the most heritable of psychiatric disorders with cross-sectional and longitudinal family, twin, and adoption studies demonstrating 70–80% heritability estimates, familial aggregation of symptoms, and familial clustering within and across generations [1].

Stuttering, a condition in which the normal pattern, rhythm, or timing of speech is disrupted, may be characterized by repetition and prolongation of words, phrases, and sounds, as well as hesitations or pauses that interrupt speech flow. Causes may be developmental, neurogenic orpsychogenic. Because mild stuttering is often self-limiting, it is rarely treated. Patients with more severe forms often require speech therapy and counseling. Pharmacological therapy has produced inconsistent results or has been limited by side effects [2].

The most common type of stuttering is developmental stuttering. Many young children develop some mild stuttering while they learn to speak. This may last for several months to years. For less than 1% of the affected children the stuttering persists beyond that and may even get worse. More boys than girls suffer from persisting developmental stuttering into adulthood. This affects daily living and health related quality of life is impaired. Some families present more stuttering. Genetic variants have been identified which may predispose speech and language difficulties [3].

Several data indicate that it may be related to a dysfunction in dopaminergic neurotransmission; moreover, it can be relieved by dopaminergic receptor blockers, and positron emissiontomography (PET) studies have shown substantial increase in dopamine uptake activity in cortical and

subcortical areas. The management of stuttering is difficult and most of the times frustrating [4].

The phenomenological profiles of ADHD and stuttering share many commonalities. For example, both disorders have higher concordance rates within monozygotic twin pairs than within dizygotic twin pairs, suggesting a primary genetic transference. Twin studies have also demonstrated that both disorders demonstrate a large environmental component, because a number of identical twin pairs were discordant. Both ADHD and stuttering occur in boys more than girls by a ratio of roughly 5:1. Both disorders have symptoms occurring during childhood and are exacerbated by stress, increase in severity over time and can be managed or controlled, at least temporarily when the child uses skills taught in behavioral interventions. Finally, ADHD and stuttering have both been associated with functional and structural neural differences in white/gray matter volume and with the circuitry of the basal ganglia .The basal ganglia, due to its location, functioning and interconnections throughout the cerebral cortex, play a significant role in the regulating of motor behaviors, emotions and cognition. These similarities led researchers to further explore the possible relationship between ADHD and stuttering. Preliminary reports estimate the comorbidity of ADHD and stuttering range from a low of 4% to a high of 26% [5].

2. Case

X. was a 6-year-old boy who presented with three month history of stuttering. The parents had noticed that his teacher complained about his hyperactivity and inattentive during both classes and breaks. The parents had also noticed that as same in school he was restless at home. He left his homework tasks half finished.

During interview in the child and adolescent psychiatry department he got out of his seat frequently and couldn't sit still. He showed difficulty in sustaining attention.

The child was diagnosed as attention deficit/hyperactivity disorder, combined presentation and childhood-onset fluency disorder (stuttering) based on the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5). The patient was started on osmotic-controlled release oral delivery system (OROS) methylphenidate 18 mg/d. The patient was followed up at first month. He demonstrated significant reduction of ADHD symptoms and total improvement of stuttering.

3. Discussion

The highly evolved neuronal networks of the dorsolateral prefrontal cortex (dlPFC) subserve working memory, our "mental sketchpad", by representing information in the absence of sensory stimulation. The importance of the dlPFC to working memory was first discovered by Jacobsen. These circuits engage in an ever-changing, intricate pattern of network activation that underlies the contents of thought, and provides top-down regulation of attention, action and emotion .Multiple neuromodulatory arousal systems project to the dlPFC, and we are now learning that neuromodulation plays an essential role in shaping the contents of our "mental sketchpad", thus coordinating arousal state with cognitive state. The critical modulatory role of the catecholamines to dlPFC function was first discovered by Brososki et al. As early as 1979, when they showed that depletion of catecholamines from the dlPFC was as detrimental as ablating the dlPFC itself [6].

The symptoms of ADHD involve impairments in prefrontal cortical top-down regulation of attention and behavior. The prefrontal cortex (PFC) intelligently regulates our thoughts, actions, and emotions through extensive connections with other brain regions, including projections the other association cortices for the regulation of sensory processing) and extensive projections to the basal ganglia and cerebellum for the regulation of motor, cognitive, and emotional responses [7].

The release of the catecholamines norepinephrine (NE) and dopamine (DA) in the PFC is related to arousal state. Low arousal conditions are associated with very low levels of NE cell firing. In contrast, under conditions of alert interest, there is moderate tonic firing, and increased phasic firing of NE and DA to relevant stimuli. Under stressful conditions, there are high levels of catecholamine release in PFC, which may arise from high, tonic firing of NE neurons, and DA neurons that respond to aversive event. Thus, the level and timing of catecholamine release in PFC can coordinate arousal state and PFC function [8].

Striato-cortico-thalamic pathways are so important both in ADHD and stuttering. Through these pathways executive functions occur. Prefrontal cortex works as a central base and it assumes role like a maestro through it's densely associations with other pathways. Disorder of prefrontal cortex effects lots of behaviours including speaking. As it is told ADHD and stuttering overlap by in many ways. Further more emotion regulation difficulties that seen in ADHD may have a role in aggravation of the stuttering. It is known that features such as excitement, anxiety increase stuttering and it is not shocking that psychostimulant works in our case. Perhaps in future psychostimulant use in permanent stuttering may be considered.

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