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Association between executive/attentional functions and caries in children with cerebral palsy

Maurício da Rocha Dourado [a], Peterson Marco Oliveira Andrade [b,d], Maria Letícia Ramos-Jorge [a], Rafaela Nogueira Moreira [a], Fernanda Oliveira-Ferreira [c,d,*]

[a] Departament of Dentistry, Federal University of Vales do Jequitinhonha e Mucuri – UFVJM, Diamantina, MG 39100-000, Brazil
[b] Departament of Physioterapy, Federal University of Vales do Jequitinhonha e Mucuri – UFVJM, Diamantina, MG 39100-000, Brazil
[c] Departament of Basic Sciences, Federal University of Vales do Jequitinhonha e Mucuri – UFVJM, Diamantina, MG 39100-000, Brazil
[d] Fernanda Oliveira-Ferreira, Federal University of Juiz de Fora, Governador Valadares, Brazil

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ABSTRACT

The aim of the present study was to evaluate the existence of an association between attention/executive functions and the development of dental caries in individuals with cerebral palsy (CP). Seventy-six children with CP were selected from a physical rehabilitation center and a school serving children with disabilities. The control group was made up of 89 children without neurological impairment. Socioeconomic status, presence of teeth with cavities due to caries, degree of motor impairment and intellectual, executive and attentional functions were assessed. Mean age of participants was 8.9 years ($SD = 3.56$). The CP group had a significantly lower performance ($p < 0.05$, Mann–Whitney test) on the intelligence, attentional function and executive function tests in comparison to the control group. Controlling for the clinical diagnosis (CP or control group), motor impairment and intellectual function, the significant explanatory variables for the presence of teeth with cavities were performance on the Complex Rey figure test ($OR = 0.941$) and the Digit Span subtest of the Wechsler Intelligence Scale for Children in backward order ($OR = 0.581$). After controlling for intellectual function, clinical diagnosis and motor impairment, deficits in executive and attentional functions increased the odds of developing dental caries in children with cerebral palsy.

1. Introduction

Cerebral palsy (CP) is a blanket term for a group of permanent movement and posture disorders attributed to non-progressive neurological disturbances having occurred in the developing fetal or infant brain (Rosenbaum et al., 2007). Motor disorders in CP are often accompanied by deficits in sensations, perception, cognition, communication and behavior as well as epilepsy and secondary musculoskeletal problems (Du, McGrath, Yiu, & King, 2010; Rosenbaum et al., 2007; Subasi, Mumcu, Koskal, Cimilli, & Bitlis, 2007). CP is traditionally classified based on the type of motor symptoms – spastic, dyskinetic or ataxic – and type of impairment – hemiplegia, diplegia or tetraplegia (Bax et al., 2005). The spastic subtype accounts for 66–82% of cases (Bottcher, 2010). CP affects approximately two individuals per one thousand live births and is the most common developmental disorder associated with lifelong motor impairment and disability (Aisen et al., 2011;

* Corresponding author at: Department of Basic Sciences, Federal University of Juiz de Fora, Avenida Doutor Raimundo Monteiro de Resende, 330, Centro, Governador Valadares, MG 35010-177. Tel.: +55 38 3532 1200.
E-mail addresses: mauricio_mrd@hotmail.com (M.d.R. Dourado), petersonmarco2007@gmail.com (P.M.O. Andrade), mlramosjorge@gmail.com (M.L. Ramos-Jorge), rafismm@yahoo.com.br (R.N. Moreira), ferreira.ufvjm@gmail.com (F. Oliveira-Ferreira).

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Uldall, Michelsen, Topp, & Madsen, 2001). Studies have reported impaired cognitive function in children with CP (Pirila, Van Der Meere, Rantanen, Jokiluoma, & Eriksson, 2011; Sigurdardottir & Vik, 2011).

According to the International Classification of Functioning, Disability and Health, higher cognitive functions, also known as executive functions, represent one of the categories related to mental functions (WHO, 2001). Executive functions are defined as the ability to control impulses, anticipate consequences, plan actions, monitor self-behavior and use feedback from the environment to temper immediate behavior and carry out long-term plans (Bottcher, 2010; Powell & Voeller, 2004). Lesions of the basal ganglia and functional thalamic systems may affect focused attention as well as executive functions (Bottcher, 2010). The changes most commonly associated with executive function deficit are impaired working memory, impulsive behavior, attention deficit and a lack of inhibition. Attentional/executive function deficits have been reported in individuals with CP (Bottcher, 2010; Bottcher, Flachs, & Uldall, 2010; Pirila et al., 2011) and may be associated with learning difficulties as well as problems regarding social relationships (Bottcher, 2010; Bottcher et al., 2010).

Oral and dental diseases in patients with CP are similar to those found in the general population, but develop earlier, more frequently and more intensely in comparison to patients without neurological impairment (Dos Santos & Nogueira, 2005; Santos, Guare, Celiberti, & Siqueira, 2009). Dental caries are defined as "*a bacterial disease process caused by acids from bacterial metabolism diffusing into enamel and dentin and dissolving the mineral. The bacteria responsible produce organic acids as a by-product of their metabolism of fermentable carbohydrates*" (Featherstone, 2008). Developmental orofacial abnormalities, the development of harmful oral (parafunctional) habits, difficulty in maintaining adequate oral hygiene and increased oral sensitivity are reported to be explanatory factors of poor oral health in patients with CP (Dougherty, 2009; Santos et al., 2009; Winter, Baccaglini, & Tomar, 2008). A number of studies have addressed these problems (De Camargo & Antunes, 2008; Dos Santos & Nogueira, 2005; Du et al., 2010), but few have investigated the relationship between mental functions and oral health (Raducanu, Cristea, & Feraru, 2008). A study involving individuals with CP found that intellectual disability explained the presence of dental caries (Moreira et al., 2012). However, the influence of specific cognitive functions, such as executive and attentional functions, on the oral health of individuals with CP had not yet been investigated. A number of studies report a relationship between attention deficits and dental caries in children and adolescents with attention deficit hyperactivity disorder, or ADHD (Blomqvist, Ahadi, Fernell, Ek, & Dahllöf, 2011; Broadbent, Ayers, & Thomson, 2004; Hidas et al., 2011). Thus, one may expect to find that deficits in executive functions may be associated with the development of dental caries in individuals with other developmental disorders, such as cerebral palsy.

As attentional/executive function deficits may limit the daily activities of children with CP, we put forth the hypothesis that these cognitive deficits hinder the maintenance of oral health. The aim of the present study was to evaluate the association between executive/attentional functions and teeth with cavities due to caries in individuals with and without CP.

2. Methods

2.1. Participants

The present cross-sectional study was conducted with individuals from a physical rehabilitation center, a public school serving children with disabilities (CP group) and a public school serving children with typical development (control group). The case group was made up of 76 patients with a medical diagnosis of spastic CP. CP diagnosis was established by neurologists and was provided in the medical reports of the patients. The inclusion criteria to the CP groups were: be aged between 7 and 12 years, to have a clinical diagnostic of spastic cerebral palsy registered in their medical records and to be able to respond to the cognitive tests, that required the movement of at least one upper limb and the understanding of verbal instructions. The control group was made up of 89 individuals without neurological impairment, selected randomly by lots from the list of children enrolled at the public school. The inclusion criteria to the control group were be aged between 7 and 12 years and do not have any neurologic impairment. To calculate the sample size, the formula for comparing two groups was used with a 95% confidence interval, 80% statistical power, 4.2 standard deviation (*SD*) of the number of teeth with cavities due to caries and a minimum difference of two teeth with cavities to be detected between groups (Santos et al., 2009). This calculation determined a minimal sample of 69 individuals per group, to which 10% was added to compensate for possible losses, resulting in a minimum of 76 individuals per group.

2.2. Procedures

Information on the characteristics (age, gender and dental history) and socioeconomic status of all participants was collected through an interview with parents/caregivers. Socioeconomic status was assessed using the Brazilian economic classification criterion (ABEP, 2011). The clinical dental exam was performed by three examiners who had undergone a training and calibration procedure (*kappa* = 0.8). The number of teeth present and number of teeth with cavities due to caries were determined in both groups based on the criteria established by the World Health Organization (WHO, 1997). All participants were submitted to a cognitive evaluation carried out by a psychologist, with expertise in neuropsychological assessment, and three trained undergraduate students assisted the psychologist during the cognitive assessment. The degree of motor impairment was evaluated by a physiotherapist using the Gross Motor Function Classification System, or GMFCS (Palisano et al., 1997).