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# Differences between the activity of the masticatory muscles of adults with cerebral palsy and healthy individuals while at rest and in function

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ABSTRACT

*Objective:* The aim of the present study was to compare the electromyographic activity of masticatory muscles of adult patients with different degrees of oral motor impairment (cerebral palsy) with the electromyographic activity of healthy individuals in a control group. Electromyographic activity was compared when the masticatory muscles were at rest and in motion.
*Design:* Thirty adult patients with cerebral palsy and 30 subjects without neuromotor disorders were enrolled in the present study. Oral motor function impairment was classified for each subject according to the Orofacial Motor Function Assessment Scale. Surface electromyography was bilaterally recorded in the masseter and anterior temporalis muscles at rest, during maximal voluntary clench and mouth opening. Comparisons between the groups were statistically assessed using Mann-Whitney test.
*Results:* At rest and mouth opening, electromyographic values were higher among patients with cerebral palsy than control group. During maximal voluntary clench, the opposite occurred. The degree of oral motor impairment affected mouth opening.
*Conclusion:* There are significant differences in masticatory muscle activity between adult patients with CP and healthy individuals, and the degree of oral motor impairment is important.
*Significance:* To improve the masticatory function of these patients, muscle therapy should approach rest, mouth opening and clenching differently.

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## 1. Introduction

Cerebral palsy (CP) is a clinical condition that is characterized by neuromotor disorders, caused by a brain injury during the prenatal, perinatal or postnatal period. Impairment of different areas of the brain results in different clinical types (Koman et al., 2004; Rosenbaum et al., 2007).

The prevalence of this condition is estimated at 2.4 per 1000 children, representing a significant number of people with this disorder (Hirtz et al., 2007).

The clinical manifestations associated with CP include loss of motor control, abnormal muscle tone, impaired coordination and an imbalance between the agonist and antagonist muscles (Castro et al., 2006; Deon and Gaebler-Spira, 2010; Koman et al., 2004). Consequently, difficulties in maintaining head posture and an unwanted bite reflex may occur (Vaughan, Neilson, & O'Dwyer, 1998; Furkim et al., 2003; Troughton and Hill, 2001; Santos, Manzano, Ferreira, & Masiero, 2005; Bigongiari et al., 2011)

In addition to motor disorders, cognitive limitations, sensory deficits, weakness and pain (with varying levels of severity) may also affect individuals with CP (Odding et al., 2006). Mastication, speech and swallowing can also be impaired. Associated disorders of the tongue, cheeks and lips often result in excessive drooling.

Concerning oral diagnoses, several scales have been developed to assess the oral motor function of patients with special needs (Ortega, Ciamponi, Mendes, & Santos, 2009). Among them, the

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Orofacial Motor Function Assessment Scale (OFMFAS) enables a quantitative assessment of the performance of oral movements (Santos et al., 2005), complementing the oral diagnosis and guiding odontological treatment and speech therapy.

Surface electromyography (sEMG) assesses muscle behavior by recording the electrical signals emitted by muscle cells, obtaining information such as the time of muscle activation, muscle activity, strength and fatigue (Hug, 2011). In cases of cerebral palsy, sEMG should be considered as a method of determining the efficiency of recommended treatment protocols and quantifying the improvement of neuromuscular functions.

Although there have been significant developments in research related to the behavior of individuals with CP in the last two decades (Blair, 2010), patients with CP still have difficulties in finding health professionals that meet and understand their needs. There is a lack of access to information about their condition and as a consequence, inadequate treatment is common (Odding et al., 2006). Furthermore, diagnosis and treatment generally emphasize the pediatric field. Health care services for adults patients with CP are limited, due to a lack of specialized professionals, insufficient financial resources and the fragmentation of health areas (Field et al., 2010).

Understanding the oral movements of individuals with CP is very important, since they directly or indirectly influence the coordinated functions of the stomatognathic system (Ries & Bérzin, 2008).

The aim of the present study was to compare the electromyographic activity of the masticatory muscles of adult patients with varying degrees of CP-related impairment with the electromyographic activity of healthy individuals in a control group.

## 2. Materials and methods

### 2.1. Inclusion and exclusion criteria

Thirty adult subjects with CP, aged from 20 to 35 years, of both genders, were enrolled in the present study based on the following inclusion criteria: patients admitted via the Training Program in Dentistry for Persons with Disabilities (PFOPD), School of Dentistry of São José dos Campos/UNESP, before the beginning of any rehabilitation treatment that could alter masticatory muscles function; quadriparetic CP; Gross Motor Function ranging from level 1 to 4, according to the classification of Palisano, Rosenbaum, Bartlett, and Livingston (2008); voluntary participation; collaborative behavior and the ability to understand and respond to verbal commands such as “open your mouth”, “close your mouth” and “clench your teeth”.

The following exclusion criteria were applied: adult patients with CP and caries; tooth mobility; absence of posterior teeth; undergoing orthodontic and/or functional orthopedic treatment. A dental examination was performed in order to avoid such factors, since they would affect the individuals biting force. Patients with level 5 Gross Motor Function were also excluded, due to their difficulty in controlling and maintaining head posture (Palisano et al., 2008). After the research had been explained in simple language and any doubts were clarified, the patients caregivers signed the informed consent form (ICF), after the volunteer's approval.

The control group contained 30 subjects aged between 20 and 35 years, of both genders, without cerebral palsy or any other health problems.

The present study received approval from the Ethics Committee on Human Research of the Dentistry School of São José dos Campos – FOSJC-UNESP under protocol number 054/2011. The project was approved by the Brazilian Clinical Trials Registry under protocol number RBR-2M9MGQ 994XFS 054/2011 (São José dos Campos, SP, Brazil).

### 2.2. Assessment of orofacial motor function

Orofacial motor function was assessed in accordance with the OFMFAS, developed by Santos et al. (2005), in order to classify the degree of impairment of patients with CP. Their protocol was followed, with the subjects positioned in a comfortable position, with the trunk and pelvis aligned and the cervical spine elongated. A dentist assessed voluntary facial movements such as jaw opening, protrusion, laterality and rapid coordinated movements. A speech therapist assessed lip, palatal and tongue movements. The scale included 30 items, for which the subject could score 0 (inability to perform the movement), 1 (partial ability) or 2 (total ability).

The final score was obtained by the sum of all the sub-item scores. Therefore, the minimum score was 0 and the maximum score was 60.

In accordance with Santos's et al. (2005), the subjects were classified as severely impaired (score $\leq 19$), moderately impaired ($20 < \text{score} < 31$), slightly impaired ($32 < \text{score} < 41$) or very slightly impaired (score $\geq 42$).

### 2.3. Surface electromyography

In order to make the acquisition of the EMG signal for adults with cerebral palsy reliable and reproducible, before the sEMG analysis, calibration of the rater and evaluation of within-day and between-day reliability of sEMG of the masticatory muscles for the same subjetct was previously tested (Giannasi et al., 2014).

The following procedures were followed in both groups: eight-channel electromyography (EMG-800C, EMG System of Brazil Ltda, Sao Jose dos Campos, SP, Brazil); calibrated with an amplification of 2000; band pass filter with a cut off frequency between 20 and 500 Hz; high common mode rejection ratio (>100 dB); analog-to-digital converter board (AD); and 16-bit resolution.

Surface electrodes were positioned on the following locations, based on the recommendations of Vitti and Basmajian (1977): 1) on the anterior portion of the right temporal muscle; 2) on the superficial portion of the right masseter; 3) on the anterior left temporal muscle and 4) on the superficial portion of the left masseter. Disposable Ag/AgCl bipolar and circular surface electrodes (Meditrace® Kendall-LTP, Chicopee, MA, USA) were used.

Two channels were used for the force transducer and mandibular goniometer.

A rectangular metallic electrode measuring $3 \times 2$ cm coated with Lectron II conductive gel (Pharmaceutical Innovations) to increase the conduction capacity and avoid interference from external noise was attached to the left wrist of the volunteer for reference.

The electromyography device was connected to a computer (HP pavilion dv4 laptop, Hewlett-Packard, CA, USA) to enable the data analysis.

The patients skin was cleaned with 70% alcohol to reduce impedance.

### 2.4. Electromyographic analysis

The sEMG recordings were initiated with both groups of patients at rest. Three 10-s recordings were taken in this position at 1 min intervals (Sforza, Rosati, de Menezes, Musto, & Toma, 2011).

It was determined that, in the presence of any physical complications or emergency, such as a convulsive seizure, procedures should be stopped immediately, thereby ensuring the patient's safety and the reliability of the examination.

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