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Original Article

Artigo Original

Peripheral facial palsy: muscle activity in different onset times

Paralisia facial periférica: atividade muscular em diferentes momentos da doença

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ABSTRACT

Purpose: To assess, through surface electromyography (sEMG), the activity of the risorius and zygomaticus muscles, during the production of voluntary smiles and to compare these data between two groups of individuals with different onset times of peripheral facial palsy (PFP). **Methods**: A total of 140 adults were divided into three groups: G1 (35 individuals with PFP onset time between 0 and 3 months); G2 (35 individuals with PFP onset time between 3 and 6 months); CG (control group) (70 healthy controls). All of the participants were submitted to the following assessments: clinical protocol for the assessment of facial mimic and sEMG of the risorius and zygomaticus muscles. **Results:** The results suggest that the groups of individuals with PFP differed from the control group considering muscle activity during rest and during the production of voluntary smiles, regardless of the onset time of the disease. The groups with PFP did not differ between themselves in any of the tested situations. The group with PFP with longer onset time presented greater muscle activation asymmetry during the production of the voluntary smiles when compared to the other two groups. Muscle asymmetry was more evident when considering the results for the risorius muscle. **Conclusion**: The results of the sEMG do not distinguish the groups when considering PFP onset times.

Descritores

Fonoaudiologia
Eletromiografia
Paralisia Facial
Paralisia de Bell
Assimetria facial

RESUMO

Objetivo: Avaliar, por meio da eletromiografia de superfície (EMGs), a atividade dos músculos risório e zigomático, durante a produção do sorriso voluntário, comparando os dados em dois grupos de indivíduos com tempos diferentes de início da paralisia facial periférica (PFP). **Métodos**: 140 adultos distribuídos em três grupos: G1 (35 indivíduos com início da PFP entre 0 e 3 meses); G2 (35 indivíduos com início da PFP entre 3 e 6 meses); GC (70 controles saudáveis). Todos os participantes foram submetidos à avaliação que consistiu na aplicação de uma escala clínica para avaliação da mímica facial e na realização da EMGs em região de músculos risório e zigomático. **Resultados:** Os resultados indicaram que os grupos com paralisia facial, independentemente do tempo de início da doença, se diferenciaram significativamente do grupo de indivíduos saudáveis quanto à atividade muscular captada durante o repouso e no sorriso voluntário para ambas as regiões musculares testadas. Os grupos com paralisia facial não se diferenciaram significativamente quando considerada a ativação muscular para nenhuma das avaliações realizadas. O grupo com maior tempo de paralisia facial apresentou ativação muscular mais assimétrica durante o sorriso voluntário quando comparado aos demais grupos. A assimetria muscular foi mais evidente considerando o funcionamento do músculo risório. **Conclusão**: Os resultados da EMGs não evidenciaram diferenças entre os grupos de acordo com o tempo de início da doença.

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INTRODUCTION

The peripheral facial paralysis (PFP) results from a neuronal injury of the VII cranial nerve and is referred to as the interruption of motor information to facial muscles[1]. Its incidence varies between 20 and 30 cases every 100 thousand individuals. Studies indicate a similar prevalence between men and women, but there are also reports in the literature demonstrating higher prevalence among women[2,3]. The idiopathic PFP or Bell's palsy is the most frequent one, representing 60 to 75% of the affected cases. However, among their causes, there can still be highlighted the following causes: traumatic, infectious, metabolic, tumor, toxic, congenital, chronic or acute medium otitis, among others[4].

In the idiopathic PFP, the clinical condition may get worse within the first 48 hours and is characterized by a great variability among the individuals, once the symptoms depend on the localization and extent of the injury to the facial nerve[5]. Most patients (about 80 to 85%) are fully recovered in about 3 months. For 15 to 20% of the cases, sequelae are observed[6]. After 6 months, it becomes more evident as to which patients will have moderate to severe sequelae[5]. PFP may result in physical, psychological, social, aesthetic, and functional disorders, once it adversely affects facial expressions (nonverbal communication) and may cause changes in the orofacial functions[7].

Studies indicate that patients with axonal loss may more often present sequelae and functional adaptations[8,9]. The sequelae occur because of the supernumerary recovery of nerve fibers, with flaws in the transmission between axons or nuclear hyperexcitability[8,9]. The most frequent sequelae are the synkinesis, characterized by an involuntary movement in association with a voluntary movement of distinct and independent muscles groups, for example, the involuntary closing of eyes when attempting to smile, voluntary movement of the forehead or eyes along with movements of the perioral region, or excessive tearing during activities such as chewing[9]. Another commonly observed sequelae is the muscle contraction, characterized by a stiffness in the affected hemiface, with absence of lines of expression, narrowing of the eye, pronounced nasolabial rhyme, filter deviated to the affected side, lifting of the corner of the mouth and nostril[8,9].

The factors pointed out make the performance of an objective evaluation difficult, which considers all aesthetic and functional aspects in an objective way[10]. As seen in other pathologies, the evaluation is a fundamental part in the control of the evolution of the disease, in determining the prognosis, treatment decision, and treatment to be followed in each case, as well as for monitoring of the results[11]. The diagnosis of the PFP is usually made by exclusion and observation of the signs and symptoms related to the innervated structures by the facial nerve, and the medical treatment with high doses of corticosteroids and antivirals is started, regardless of the prognosis or other rehabilitation and/or surgical treatments to be performed[5,12,13].

Based on evidence-based practice, it is important to use standardized and validated evaluations to relate the interventions adopted and the results, thus, verify their efficacy[14]. In this sense, some evaluation scales were proposed involving the perceptual clinical evaluation of the symmetry of the face at rest, the voluntary movements, and the identification of possible related sequelae[15]. The internationally known scale is the *Facial Nerve Grading System*, which does not allow a full evaluation of the facial muscles or the presence of contractures or synkinesis[16]. Another commonly used scale is the *Sunnybrook Grading System*, which includes the evaluation of the face muscles at rest, in voluntary movements, and the observation of synkinesis. Studies point out that the use of those scales does not depend on the experience of the evaluator[17]. Thus, the clinical scales present higher reliability for the evaluation of voluntary movements, possibly because of the difficulty in measuring the spontaneous function or the involuntary movements[18].

Objective tests for the evaluation of PFP include the use of electromyography (EMG), which allows evaluating the degree of degeneration of the nerve to define a prognosis[19]. However, this test is highly invasive, painful, and of limited use in clinical practice, considering that the equipment is found only in a few institutions.

In this sense, the surface electromyography (sEMG) has been used as an auxiliary test for the diagnosis and treatment of oral myofunctional disorders, swallowing, chewing, and speaking. It is a painless and noninvasive procedure, which allows the study of peripheral superficial muscle activity during the production of voluntary and involuntary movements[20,21]. Recent studies used the EMG for the evaluation of voluntary smiling in patients with long-term PFP — more than 2 years after its beginning — for the correlation of impairment of the face muscles with a self-evaluation questionnaire on quality of life[20]. The hypothesis of this study was that the individuals with greater facial symmetry would have greater impairment in quality of life. However, the results of the study indicated that there was no correlation between the objective test and the self-evaluation scale. In this study, it was observed that the EMG was able to identify significant differences between the paralyzed and the non-paralyzed side of the face.

The objective of this study was to evaluate, through EMG, the muscle activity of the risorious and zygomatic region, during the production of voluntary smiles, comparing the data of the myoelectric activity in two groups of individuals with different times for the onset of PFP.

METHODS

The processes of selection and evaluation of the participants followed the appropriate ethical procedures. The project was approved by the Research Ethics Committee of the School of Medicine of the *Universidade de São Paulo* (CAPPesq HCFMUSP No. 214.596) and all participants signed the informed consent.

Participants

A total of 140 individuals aged between 18 and 60 years of age, both gender, took part in the study, and were distributed into three groups: Group 1 (G1), consisting of 35 participants affected by the PFP who had the onset of their condition

between 0 and 3 months of age; Group 2 (G2), consisting of 35 participants affected by the PFP who had the onset of their condition between 3 and 6 months of age; and Control Group (CG), consisting of 70 healthy volunteers, paired up according to age and gender to the G1 and G2.

All participants in G1 and G2 were evaluated within a period of 12 months, in the Speech Language and Audiology Department of the Central Institution of the *Hospital das Clínicas*, School of Medicine, *Universidade de São Paulo*. To get included in the research, the participants of both groups should meet the following inclusion criteria:

- providing diagnosis, according to the medical chart of the Institution, of the idiopathic etiology of PFP or Bell's;
- having been submitted to medical treatment with corticosteroids and antivirals, according to the protocol of the Institution;
- absence of neurological and/or cognitive comorbidities;
- absence of history of recurrent PFP;
- absence of history of trauma and/or surgery in the head and neck;
- absence of asymmetries resulting from craniofacial deformities;
- absence of previous speech language and audiology intervention;
- absence of history of alternative treatments for the PFP (e.g., electrical stimulation, acupuncture);
- having scored between 1 and 18 in the Mime Functional Evaluation[22].

To be included in the CG, all participants should meet the following inclusion criteria:

- lack of medical history of facial palsy;
- absence of neurological and/or cognitive comorbidities;
- absence of history of trauma and/or surgery in the head and neck;
- absence of asymmetries resulting from craniofacial deformities;
- absence of previous speech language and audiology intervention;
- scoring between 19 and 20 in the Mime Functional Evaluation[22].

Procedures

Mime Functional Evaluation

The facial mime was evaluated according to the Clinical Protocol for Mime Functional Evaluation[22]. This protocol evaluates in a perceptual way the impact of the PFP in the ability of the individuals in performing symmetrical facial movements, assigning scores for each of the hemifaces. All evaluations were recorded using a digital camera by SONY, model DSC-W120.

The muscles of the face were evaluated during the performing of different voluntary facial expressions, scoring according to the following criteria: zero (0) if there were no movements; one (1) for partial or moderate movements; and two (2) for full or complete movements. The protocol also considers involuntary movements, observing patients during blinking, speaking, and in the production of spontaneous smiles, using the following scoring criteria: zero (0) when absent, one (1) when reduced, and two (2) when normal. For the deformities of lips and eyelids and the presence of synkinesis or hypertonia, negative values were used: zero (0) if absent, (-1) for partial or slight deformities, and (-2) for full or severe deformities. At the end, the sum of the partial values obtained corresponds to the final result, which may vary from -6 to 20 points for each hemiface.

Instrumental evaluation: surface electromyography

The electromyographic evaluation of the muscle groups involved in the smile (risorius and zygomatic) was carried out based on the methodology previously published in the literature[20]. All participants were evaluated in the same way.

To perform the EMG, a Miotool Electromyograph 400 with 4 channels, calibrated at 500 microvolts (μV) with pass band filter (20–500 Hz) and gain of 100 times, with low level of noise (<5 μV RMS [root mean square]) was used. The software used for capturing and processing in the EMG test was the Miograph 2.0, by Miotec® Biomedical Equipments, which makes the acquisition, storage, and online processing of signs, and runs on Windows XP operating system. The signs of electrical activity of muscle movements were captured by surface bipolar electrodes Ag/ACGl, disposable, model SDS500, double, fixed with transpore tape (by 3 M).

All EMG tests were carried out by a speech language and audiology therapist with experience in this field, under the same environmental conditions. The positioning of the electrodes followed the technique of placing the midpoint of the muscle belly in the longitudinal direction of the muscle bundle in the mesodistal position of the muscle, where it may be observed under higher amplitude of signal for this kind of electrode. To ensure the correct position of the electrodes, an identification of the risorius and zygomatic muscles by palpation during rest and at maximal contraction was performed —the participant was asked to reproduce a smile with the maximum amplitude. After this step, the muscle function was tested to verify the possible positioning mistakes and a new placing of the electrodes was made, if necessary.

The electrical activity of the risorius and zygomatic muscles was evaluated in both hemifaces. Each muscle region was evaluated separately, during the following tasks: at rest and voluntary smiles with maximum amplitude.

For the collection of data, all participants sat on a chair, with their backs supported, feet flat on the floor, hands resting on the lower limbs, head properly positioned (Frankfurt plan parallel to the ground), and with eyes open and searching for a predetermined fixed point. All individuals were informed about the test. The skin of the face was prepared using a gauze soaked in alcohol (70%) and a local shaving was done, to ensure good impedance during the test. The signs obtained were analyzed in RMS and expressed in microvolts (μV). The reference cable (earth) was connected to the electrode and fixed on the right wrist.

First, the collection of the risorius and zygomatic muscles was performed at rest for 30 seconds. Three collections were performed to obtain the mean electrical activity. Up next, the participants were asked to remain at rest for 15 seconds, without

recording. After this pause, a collection of the electrical activity of the muscles at maximum contraction was performed, the participant being asked to smile with maximum amplitude for 5 seconds, three consecutive times, with an interval of 5 seconds between them. Three trials with three repetitions of smiles were recorded for each muscle, totaling nine samples per muscle region. There was an interval between the recording trials so that the basal activity of the muscles could return to the resting level and thus avoid fatigue.

Analysis of the electromyographic data

For the analysis of the EMG results, an analysis of the temporal domain was performed. In this analysis, the information obtained describes in which moment the event occurred and the range (indicator of the magnitude of the muscle activity) of its occurrence. At rest, the values obtained represented the mean (RMS) of the electromyographic activity observed in 30 seconds. The amplitude of the muscle activity during the task of smiling was obtained by the selection of a representative section of the muscle activity (*on* and *off* situation. The *on* situation was determined by the beginning of the muscle contraction above the basal values. The *off* one was determined by the return of the muscle to its basal activity. This section was selected with the cursor of the EMG software itself and converted into microvolts.

The amplitude values of EMG were normalized based on the recordings regarding the maximum contraction values for the comparison of the results among the participants. For comparison among the groups, the coefficient of asymmetry between the hemifaces for each muscle region, both at rest and while smiling, was calculated. This coefficient was obtained as follows: for G1 and G2, ratio between the muscle activity obtained in the paralyzed and the non-paralyzed sides (paralyzed side/non-paralyzed side); for CG, ratio between the muscle activity obtained on the right and on the left sides of the face (right side/left side). It was considered that the values closest to one (1) would be representative of more symmetrical faces.

Reliability

Based on the related literature, which points out subjectivity in reading the EMG measure, an analysis of reliability was performed to determine the level of agreement between the examiners and thus ensuring greater reliability of the measures. For such, 300 electromyographic samples were randomly selected, independently, by two speech language and audiology therapists, from a total of 2,940 samples. These samples were evaluated, independently, by two speech language and audiology therapists with experience in the field, blinded to the study. The correlation coefficient was high for all comparisons, with 95% confidence interval (95%CI) of 0.8823–0.9167, indicating high consistency between the examiners.

Analysis of the data

The descriptive analysis for the quantitative data was carried out with the mean values followed by their respective standard deviation. The quantitative data without normal distribution were expressed by their mean values followed by their respective interquartile intervals (25–75%). The assumption of the normal distribution in each group was evaluated with the Shapiro–Wilk test. The categorical variables were expressed through their frequencies and percentages.

The Kruskal–Wallis test was used for the intergroup statistical analysis. For multiple comparisons, the Dunn test was used. The Wilcoxon test was used for the intragroup statistical analysis. The significance level adopted was 5% for all analysis.

RESULTS

In relation to the distribution and overall characterization of the groups, the following results were observed: in G1, 18 men (51.43%) and 17 women (48.57%), with a mean age of 43.08 (±11.42) years, considering that 22 (62.85%) individuals had their right hemiface affected by the PFP and 13 (37.15%) individuals their left hemiface; in G2, 15 men (42.86%) and 20 women (57.14%), mean age of 40.80 (±9.08) years, considering that 15 (42.85%) individuals had their right hemiface affected by the PFP and 20 (57.15%) individuals their left hemiface; in the CG, 33 men (47.14%) and 37 women (52.86%), mean age of 41.94 (±10.32) years. The three groups were homogeneous for the mean age and gender distribution.

Table 1 presents the results of the Kruskal–Wallis test for intergroup comparison of the myoelectric activation in zygomatic regions at rest and during a voluntary smile. The results indicate significant differences for the situation of rest in the following comparisons: G1 *versus* CG, both for the paralyzed and the non-paralyzed sides (p=0.040, for both comparisons); G2 *versus* CG (p<0.001, for both comparisons). No difference

Table 1. Intergroup comparison for the data of surface electromyography in zygomatic region (in microvolts – μV)

Condition	Minimum	Maximum	Median (QRI)
G1			
At rest			
P	1.3	30.97	3.93 (2.9–7.7)
NP	1.37	29.53	3.87 (2.6–7.1)
Smiling			
P	1.43	100.8	26.50 (16.4–37.9)
NP	1.7	131.23	23.10 (16.2–39.0)
G2			
At rest			
P	2.27	23.95	4.73 (3.7–7.0)
NP	2.5	30.28	4.75 (3.5–6.9)
Smiling			
P	10.22	51.68	19.77 (15.9–28.2)
NP	8.47	172.32	25.08 (17.3–50.9)
CG			
At rest			
R	1.02	7.25	3.10 (2.5–4.0)
L	1.49	7.4	3.08 (2.3–4.6)
Smiling			
R	11.52	146.62	59.14 (38.3–94.5)
L	19.25	152.78	62.07 (36.6–96.9)

Caption: QRI = interquartile interval; G1 = 0–3 months of paralysis; G2 = 3–6 months of paralysis; CG = control group; P = paralyzed hemiface; NP = non-paralyzed hemiface

was found for the comparison between G1 and G2 (p=0.661 for the paralyzed side; p=0.173 for the non-paralyzed side). When analyzing the descriptive statistics regarding the myoelectric activity at rest, it was observed that the G1 and G2 had higher electromyographic values at rest when compared to the CG, the variability of the data was also higher for the groups affected by facial palsy.

During the task of voluntary smiling, the analysis indicates a significant difference for the activation of the zygomatic muscle in the following comparisons: G1 *versus* CG (p<0.001), both for the paralyzed and the non-paralyzed sides; G2 *versus* CG (p<0.001), for both situations. There was no significant difference for the comparison of G1 and G2 (p=0.999 for the paralyzed side; p=0.999 for the non-paralyzed side). The descriptive data indicate that for the groups with facial palsy there was lower muscle activation in the paralyzed side when compared to the non-paralyzed one, in addition to the great variability of the data. For the CG, although a variability of the data was also observed, this variation was lower and the sides of the face work in a more symmetrical way.

Table 2 presents the results of the Kruskal–Wallis test for intergroup comparison of the myoelectrical activation in risorius region at rest and during voluntary smiling. The results indicate significant differences at rest for the following comparisons: G1 *versus* CG, both the paralyzed and the non-paralyzed sides (p=0.050 for the paralyzed side; p=0.001 for the non-paralyzed side); G2 *versus* CG (p=0.008 for the paralyzed side; p<0.001 for the non-paralyzed side). There were no differences for the comparison between G1 and G2 (p=0.999 for the paralyzed side; p=0.999 for the non-paralyzed side). When analyzing the descriptive statistics regarding the myoelectric activity at rest, it was observed that G1 and G2 had higher electromyographic values at rest when compared to the CG, the variability of the data was also higher for the groups affected by facial palsy.

During the task of voluntary smiling, the analysis indicates a significant difference for the activation of the risorius muscle in the comparisons: G1 *versus* CG (p<0.001) and G2 *versus* CG (p<0.001), only when comparing the activation of the paralyzed side. The descriptive data indicate that for the groups with facial palsy there was lower muscle activation of the paralyzed side when compared to the non-paralyzed one. However, the muscle activity of the non-paralyzed side was higher for both groups when compared to the CG, highlighting the muscle imbalance.

The intergroup analysis for the facial asymmetry coefficient for the activation of the zygomatic and risorius muscles during the task of voluntary smiling is presented in Table 3. There was a significant difference between the groups only for the muscle activity of the risorius muscle. Considering that the closest to 1 (one), the greater the facial symmetry, G2 had greater facial symmetry for both the zygomatic and the risorius muscles. The CG was the most symmetrical one during voluntary smiling.

Table 4 presents the results for the Wilcoxon test for intragroup comparisons between the hemifaces for the zygomatic muscle at rest and during voluntary smiling. A significant difference was observed between the hemifaces only in G2 while smiling.

Table 5 presents the results of the Wilcoxon test for intragroup comparison between the hemifaces for the risorius muscle at rest and during voluntary smiling. A significant difference was observed between the hemifaces for G1 and G2 during smiling.

Table 2. Intergroup comparison for the data of surface electromyography in risorius region (in microvolts – μV)

Condition	Minimum	Maximum	Median (QRI)
G1			
At rest			
P	0.63	140.2	5.90 (2.3–20.5)
NP	1.57	185.5	5.43 (2.9–30.0)
Smiling			
P	0.83	191.77	27.80 (18.4–50.3)
NP	8.53	553.1	54.97 (31.1–101.6)
G2			
At rest			
P	1.83	111.58	6.52 (3.0–9.4)
NP	1.67	111.78	5.95 (3.4–15.9)
Smiling			
P	5.3	147.68	32.58 (26.8–43.6)
NP	9.28	215.35	45.25 (29.3–90.9)
CG			
At rest			
R	1.05	24.33	3.55 (2.5–5.7)
L	1.07	24.48	2.87 (2.1–4.1)
Smiling			
R	16.53	195.22	77.64 (43.1–131.7)
L	19.25	195.36	77. 64 (42.9–127.9)

Caption: QRI = interquartile interval; G1 = 0–3 months of paralysis; G2 = 3–6 months of paralysis; CG = control group; P = paralyzed hemiface; NP = non-paralyzed hemiface

Table 3. Intergroup analysis for the facial asymmetry coefficient

Group	Zygomatic region		Risorius region	
	Median (QRI)	p-value	Median (QRI)	p-value
G1	0.88 (0.59–1.50)		0.76 (0.23–0.99)	
G2	0.72 (0.33–1.21)	0.304	0.71 (0.45–1.03)	0.004*
CG	0.91 (0.59–1.41)		0.94 (0.69–1.58)	

*significant result.

Caption: QRI = interquartile interval; G1 = 0–3 months of paralysis; G2 = 3–6 months of paralysis; CG = control group

Table 4. Intragroup comparison between the hemifaces for the data of surface electromyography in the zygomatic region (in microvolts – μV)

Group	PS/RS	NPS/LS	p-value
	Median (QRI)	Median (QRI)	
At rest			
G1	3.93 (2.87–7.67)	3.87 (2.60–7.07)	0.961
G2	4.73 (3.70–7.03)	4.75 (3.52–6.92)	0.334
CG	3.10 (2.51–4.00)	3.08 (2.28–4.61)	0.845
Smiling			
G1	26.50 (16.40–37.87)	23.10 (16.17–39.03)	0.687
G2	19.77 (15.97–28.18)	25.08 (17.33–50.98)	0.017*
CG	59.14 (38.28–94.48)	62.07 (36.57–96.91)	0.112

*significant result.

Caption: PS = paralyzed side; RS = right side; NPS = non-paralyzed side; LS = left side; QRI = interquartile interval; G1 = 0–3 months of paralysis; G2 = 3–6 months of paralysis; CG = control group

Table 5. Intragroup comparison between the hemifaces for the data of surface electromyography in the risorius region (in microvolts – μV)

Group	PS/RS	NPS/LS	p-value
	Median (QRI)	Median (QRI)	
At rest			
G1	5.90 (2.30–20.47)	5.43 (2.87–30.03)	0.073
G2	6.52 (3.05–9.45)	5.95 (3.43–15.95)	0.572
CG	3.55 (2.50–5.67)	2.87 (2.15–4.12)	0.212
Smiling			
G1	27.80 (18.43–50.27)	54.97 (31.10–101.67)	<0.001*
G2	32.58 (26.85–43.68)	45.25 (29.38–90.87)	<0.001*
CG	77.64 (43.06–131.71)	77. 64 (42.99–127.97)	0.592

*significant result.

Caption: PS = paralyzed side; RS = right side; NPS = non-paralyzed side; LS = left side; QRI = interquartile interval; G1 = 0–3 months of paralysis; G2 = 3–6 months of paralysis; CG = control group

DISCUSSION

Overall, the results in this study indicate that the groups with facial palsy, regardless of the time of onset of the disease, significantly differ from the group of healthy individuals in the muscle activity captured at rest and during voluntary smiling for both the muscle regions tested. The groups with facial palsy do not differentiate significantly when considering the muscle activation for none of the evaluations performed. G2, with longer time of facial palsy, had more symmetrical muscle activation during voluntary smiling when compared to the other groups. Muscle symmetry was more evident when considering the functioning of the risorius muscle.

Despite having observed a great variation of results for muscle activation between individuals with and without facial palsy, there was a significant difference in the muscle activation while voluntary smiling when comparing the paralyzed and the non-paralyzed sides, both for G1 and G2. The same was not observed for the CG, indicating a more symmetrical muscle function. The asymmetry in muscle function of patients with facial palsy has already been described in the literature, based on the need for integrity of the facial nerve to ensure balance and symmetry in the production of facial expressions[20,22,23].

Facial palsy causes anatomical and physiological changes. The asymmetries may be caused not only by absence/reduction, but also by excessive muscle activation of the non-paralyzed side[6,9,20]. Considering the groups with facial palsy, the difference of activation between the hemifaces, for the risorius muscle, is approximately between 30 and 50% because of the greater use of the muscles on the paralyzed side. As for the CG, the differences between the hemifaces did not exceed 5%. Studies carried out with an invasive EMG, which is a more accurate procedure for muscle evaluation, indicated that the healthy human face may present up to 6% of symmetry during the production of facial expressions[21].

The acute unilateral facial palsy is the most common disease of the facial nerve[19]. Most of those cases end up being diagnosed as idiopathic facial paralysis (Bell's palsy), once the cause of the disease is not identified, with an early use of oral steroids as a traditional medical treatment[12,24]. The great challenge of the studies is in determining prognosis indicators for the probability and time of recovery for patients, as the existing studies have low casuistry and are mostly retrospective[19]. It is known that much more than the underlying cause for paralysis, the severity of the damage to the facial nerve is crucial in the recovery of movements[19]. In this study, it was not possible to characterize, by means of peripheral muscle function, significant differences between individuals with short-term facial paralysis (0–3 months) and the long-term one (3–6 months). The results of the study suggest that for each group with longer duration of the paralysis, the sequelae of the facial lesion are more evident. According to the literature, the change in facial muscle functions is a condition, which may be associated to vegetative alterations such as the absence or reduction of tearing, vascular alterations, or co-contractions of surrounding muscles in the case of functional muscle imbalance, as in the case of facial palsy[25].

A recent prospective study, which evaluated 259 patients with peripheral facial palsy[19], concluded that despite the importance of clinical evaluation protocols in the follow-up of facial palsy patients' recovery, the evaluation by invasive EMG is able to provide more accurate data on the degree of facial motor impairment of the patient and, therefore, it allows predicting the possibility of facial movement recovery. However, this test is not always available in the institutions that receive these patients for diagnosis and treatment, in addition to it being an invasive and painful procedure for the patient.

Currently, there is no universally accepted scale for the evaluation and follow-up of the patients with facial paralysis[11]. The existing methods differ a lot from each other in the way of evaluating the patient, which causes difficulty in the comparison of the findings in the studies. Besides, little attention is given to the validation and reproducibility of the data. Despite the difficulties inherent to the application and interpretation of the sEMG (the signal is highly influenced by the environment, intra- and intersubject impedance variations of skin, difficulty in isolating a muscle group, etc.), the technological advances of the equipment for capturing and processing signal have been improving the quality of the information obtained with the procedure[26]. In this study, the compatibility of data analysis indicates that the muscle evaluation of the face by EMG is reproducible and is able to differentiate individuals with and without muscle impairment.

Finally, one of the limitations of the study is that, because of the number of individuals in each group with facial paralysis and the variability in the manifestation of the severity of the disease, it was not possible to work with the subgroups to compare individuals with the same severity, but with different times of onset for the paralysis. More studies are necessary so that the difference between the muscle activation among the individuals with and without facial palsy may be characterized with greater specificity. A future study intends to longitudinally monitor, by EMG, individuals with PFP undergoing speech language and audiology treatment, with the objective of verifying which patients benefit from the muscle rehabilitation and which are the indicators of improvement in muscle function.

CONCLUSION

The results in this study indicate that the groups with facial palsy, regardless of the time of onset of the disease, significantly differ from the group of healthy individuals as far as the muscle activity captured at rest and during voluntary smiling is concerned. The results of the EMG did not indicate differences among the groups according to the time of onset of the disease. The groups with higher time of onset of facial paralysis presented more symmetrical muscle activation during voluntary smiling when compared to the other groups. Muscle asymmetry was more evident for the evaluation of the risorius muscle.

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