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Original articles

The effect of the neuromuscular electrical stimulation on the suprahyoid muscle activity during swallowing in subjects with dysphagia

O efeito da eletroestimulação neuromuscular na contração da musculatura supra-hióidea durante a deglutição de indivíduos com disfagia

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Conflict of interest: non-existent

ABSTRACT

Purpose: the purpose of this study is to verify the effect of Neuromuscular Electrical Stimulation on the suprahyoid muscle activity during swallowing, in post stroke subjects, with oropharyngeal dysphagia. **Methods:** participated eight post-stroke subjects with dysphagia, male and female, referred to speech-language therapy to early swallowing rehabilitation. Before the first rehabilitation session, the patient´s muscular electrical activity of suprahyoid muscle was measured using Surface Electromyography Biofeedback. Patients were randomly divided into two groups: Experimental Group (n=4): patients who received both traditional speech-language therapy and the application of Neuromuscular Electrical Stimulation. Control Group (n=4): patients submitted to traditional speech-language therapy. After eight sessions, all patients measured the suprahyoid activity with the Surface Electromyography Biofeedback. The pre and post treatment results were compared in both groups. **Results:** comparing the two groups average of time and amplitude of the muscle contraction during swallowing of saliva and two swallows of paste, no statistically significant differences were observed in the pre and post treatment values. **Conclusion:** the use of Neuromuscular Electrical Stimulation on the parameters and methodology used did not prove efficient in promoting greater contraction of the suprahyoid muscles during the swallowing, in post-stroke individuals with oropharyngeal dysphagia. The data obtained may be due to the methodology used in this study relative to the protocol application and the way to measure the results.

Keywords: Transcutaneous Electric Nerve Stimulation; Deglutition Disorders; Stroke; Speech Therapy; Electromyography

RESUMO

Objetivo: verificar o efeito da Eletroestimulação Neuromuscular na contração da musculatura supra-hióidea durante a deglutição em indivíduos pós-Acidente Vascular Cerebral com disfagia orofaríngea. **Métodos:** participaram da pesquisa oito indivíduos pós-Acidente Vascular Cerebral com disfagia, de ambos os sexos, encaminhados para terapia fonoaudiológica com objetivo de trabalhar a função da deglutição, em início de processo terapêutico. Anteriormente ao início da primeira sessão, foi realizada a mensuração do tempo e amplitude da atividade elétrica muscular através da Eletromiografia de Superfície de Biofeedback. Os pacientes foram divididos aleatoriamente em dois grupos: Grupo Experimental (n=4): pacientes que receberam a fonoterapia tradicional e aplicação da Eletroestimulação Neuromuscular; Grupo Controle (n=4): pacientes que receberam a fonoterapia tradicional. Após oito sessões, todos os pacientes passaram novamente pela Eletromiografia de Superfície de Biofeedback para verificar a atividade elétrica da musculatura supra-hióidea. Os registros dos exames pré e pós intervenção foram comparados nos dois grupos. **Resultados:** comparando-se as médias das variáveis de amplitude e tempo da atividade elétrica muscular durante a deglutição de saliva e nas duas deglutições de pastoso, não foram observadas diferenças estatisticamente significantes entre os grupos estudados, na comparação dos valores pré e pós intervenção. **Conclusões:** o uso da Eletroestimulação Neuromuscular nos parâmetros e na metodologia empregada não mostrou-se eficiente em promover maior contração da musculatura supra-hióidea durante a deglutição em indivíduos pós-Acidente Vascular Cerebral com disfagia orofaríngea. Os dados encontrados podem ser decorrentes da metodologia utilizada nesta pesquisa com relação ao protocolo de aplicação da técnica e à forma de mensuração dos resultados.

Descritores: Estimulação Elétrica Transcutânea; Transtornos da Deglutição; Acidente Vascular Cerebral; Fonoterapia; Eletromiografia

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INTRODUCTION

The deglutition is responsible for leading the food to the stomach, thus assuring the nutritional aspect, and for protecting the lung of the aspiration of the food and/or saliva. Deglutition disorders lead to the presence of oropharyngeal dysphagia, which can bring clinical problems, such as malnutrition, dehydration and pulmonary complications. In post-stroke patients the main risk factor for the occurrence of aspiration pneumonia is the presence of dysphagia[1]. According to studies, 51% of post-stroke patients present changes in swallowing function in acute phase[2].

In the presence of oropharyngeal dysphagia, several rehabilitation techniques have beem used to minimize the clinical impact, as compensation (changes in consistencies, cervical postures and eating utensils) and active exercises that act in the muscles of tongue, pharynx, larynx, supra and infra-hyoid. Since the 90´s decade, Neuromuscular Electrical Stimulation (NMES) has been used internationally in the rehabilitation of oropharyngeal dysphagia. In Brazil, its use for this purpose in a more evident way a few years ago[1].

Studies have investigated the use of NMES in the rehabilitation of oropharyngeal dysphagia in poststroke individuals, showing benefits in swallowing biomechanic[3].

The use of NMES for dysphagia aims establish or restore the minimum conditions of contraction, muscle functionality, proprioception and kinesthesis linked directly and indirectly to laryngeal mobility in swallowing and its phases. Electrical stimulation in the muscle has immediate effects, such as muscle contraction and muscle disorders. Over the long term there is a muscle strengthening and structural changes in muscle fibers[4].

The scientific literature about the therapeutic effectiveness of NMES in dysphagia is still controversial, lying since studies[5-7] that does not correlate improvement of biomechanic of swallowing as a result of its use, as well as studies that verified this biomechanic optimization and, consequently of dysphagia[1,3,8-16].

Due to clinical problems of dysphagia and the need to use techniques that can accelerate the process of rehabilitation of swallowing, it is necessary to verify quantitatively and objectively the effects of NMES on suprahyoid muscles and consequently in swallowing for patients with neurological impairment.

The choice of suprahyoid muscles (mylohyoid muscles, genius-hyoid, digastric and style-hyoid) to evaluate the effect of NMES in dysphagia intervention occurs for the importance of the contraction of these muscles in the swallowing. This contraction promotes the elevation, forward and stabilization of the hyoid bone during swallowing, protecting the lower airway from aspiration of saliva and/or food.

Thus, this study aimed to verify the effect of NMES in the contraction of suprahyoid muscles during swallowing in post-stroke patients with oropharyngeal dysphagia.

METHODS

This study was approved by the Ethics Committee of the Associação de Assistência à Criança Deficiente (AACD), protocol number 783,444. A Term of Consent was given to the patient or his responsable.

Participated in this study eight post-stroke individuals in chronic phase, both sexes, with oropharyngeal dysphagia referred for speech therapy with the purpose of work the swallowing function in a reference center of physical rehabilitation.

The diagnosis of oropharyngeal dysphagia was carried out by a specialized speech therapist, during clinical evaluation of swallowing at the start of subject´s rehabilitation at the center. In addition to the diagnosis of dysphagia, the patient should specifically present deficit in the hyoid elevation during swallowing, showing weakness in the suprahyoid muscles during this function. The deficit in the hyoid elevation was also verified during the clinical evaluation of swallowing.

It is known that the location of brain injury in post-stroke patients can bring different cognitive and sensorimotor symptomatology, therefore uniform the brain injury location would promote greater homogeneity of the group of patients investigated. However, even in hospitals and rehabilitation centers of reference, there is great diversity with regard to this location, making it hard the formation of groups of patients for studies, since the number of patients would be reduced. In this way, it was decided in this study to seek the homogeneity of the patients studied by pathophysiology of swallowing presented, as this function is the object of study and will suffer the influence of therapeutic interventions.

Patient	Gender	Age	Injury	Injury time	Group
1	Female	34	CVAi brainstem	3m	experimental
2	Masculino	70	CVAi right	8y	experimental
3	Female	81	CVAi right	4y	controle
4	Female	63	CVAi right	2a	controle
5	Female	57	CVAh cerebellar	3a	experimental
6	Female	53	CVAi right	2a	controle
7	Female	84	CVAh cerebellar	1a2m	controle
8	Female	57	CVAi right	4a6m	experimental

Legenda: CVAi = ischemic cerebro vascular accident; CVAh hemorrhagic cerebro vascular accident; y=years; m=months.

Figure 1. Data according to gender, age (years), type and time of brain injury and the research group of patients in this study

Aiming to prevent clinical problems resulting from dysphagia, like the occurrence of aspiration pneumonia, all the patients in this study received speech orientation with respect to consistency, volumes, utensils and posture to eat, to reduce or eliminate clinical signs of tracheal aspiration, and promote nutritional gain.

The patients in this study were divided randomly into two groups:

- Experimental group: patients who received NMES concomitant to the traditional speech therapy;
- Control Group: patients receiving only traditional therapy.

The randomization process was conducted by lot, being initially chosen patients who were part of the experimental group. The exclusion criteria were the presence of: tracheostomy tubes that could influence the dynamics of swallowing; exclusive feeding tube due to the probable impossibility for swallowing training with food in the short-term therapy; cognitive and/or language changes that hindered the miofunctional active exercises; convulsive syndromes or cardiac pacing, which impede the use of NMES in the cervical region; history of speech therapy with previous use of NMES in suprahyoid region.

In all of the subjects in this study were measure the amplitude and time of the electrical activity of suprahyoid muscles during swallowing, before the first therapy session. This measurement was performed by biofeedback surface electromyography (sEMG-biofeedback), with use of electromyograph "Myotrac Infiniti" of brand "Thought Technology Ltda". The amplitude and time of muscular electrical activity were obtained through adhesive electrodes with a diameter of 2 cm, positioned and fixed in suprahyoid area (photo 1) with the skin previously cleaned with gauze soaked in 70% alcohol. The researchers requested for the patient one swallowing of saliva, and later two swallows of 3 ml of homogeneous paste food, measured in syringe and offered in metal teaspoon. The graphics about the amplitude and time curves obtained by the equipment used was stored in computer files for later analysis.

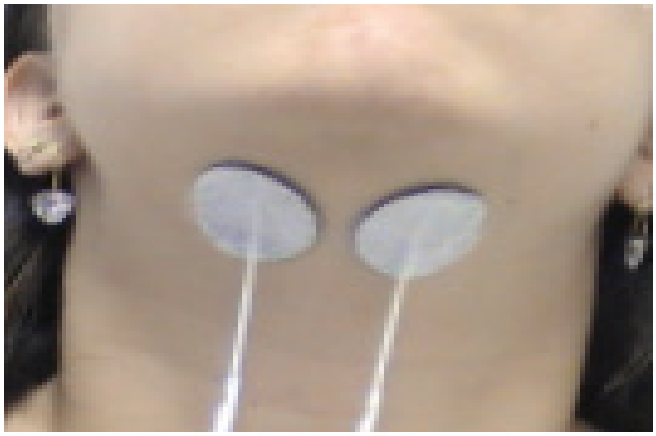

Figure 2. electrode placement illustration in suprahyoid region

After collecting data, patients receive the therapeutic activity assigned accordance with the group in which they belonged. The traditional speech therapy included the realization of active myofunctional exercises that promote contraction of suprahyoid muscles, associating them with saliva or food swallowing, in a safe consistency to patient. They were: use of respiratory exerciser to promote blow with strength[17,18], the sharp production of the phoneme /i/, Shaker maneuver and maneuver Shaker adaptada[19-21], tongue opposition against palato[22], maneuver Masako[23] and protrusion tongue[24] with and without resistance. To avoid influence of gains in other aspects of swallowing function that promote possible increase in the contraction of suprahyoid muscles, were not performed other therapeutic techniques such as extra and intraoral stimulation, oral

exercises and application of elastic bandage in the sessions established by the study.

The use of NMES in the experimental group included the application of electric stimulus through two adhesive electrodes 3 cm in diameter applied on clean skin in suprahyoid muscles area. The application of electrical stimulus occurred in combination with the realization of active exercises already described in the traditional speech therapy, and followed the protocol that has been used by speech therapy department in the rehabilitation center in which the research was conducted:

- five minutes of application of Transcutaneous Nerve Stimulation (TENS), frequency of 30 Hz and pulse 200ms, in order to promote greater proprioception of the patient on the muscles being worked. The intensity is adjusted in accordance with the comfort level of each patient;
- twenty minutes of application of Electrical Stimulation Functional (FES) frequency of 80 Hz and pulse 250ms, with a time of five seconds with the power on (time on), alternating with ten seconds of rest (off current - time off) with order to provide the contraction and muscle strengthening. The intensity is adjusted in accordance with the comfort level of each patient;
- five minutes new application of TENS current with 30Hz frequency and pulse 200ms, aiming muscle deceleration at the end of the session. The intensity is adjusted in accordance with the comfort level of each patient.

Therapy sessions for both groups occurred weekly for 40 minutes. After eight sessions, all patients measure the EMG biofeedback again to check the amplitude and time of muscle electrical activity during swallowing saliva and two swallowing of paste food, with the same volume and utensils used in the pre intervention measurement. The electrodes and the placement of these were also maintained accordance with the initial measurement. The choice of eight sessions to a new survey of the data was based on criteria of the institution where the research was developed, which is the stipulated time to check progress of any therapeutic process applied.

The records of the pre-intervention and post-intervention survey were compared in both groups. The data collected were analyzed and discussed according to the literature.

Statistical analysis

For statistical analysis we used the MS-Excel electronic spreadsheet in its MS-Office 2010 version for the data organization, and IBM SPSS (Statistical Package for Social Sciences), in its version 22.0, to obtain the results. In the statistical analysis, we adopted the significance level of 5% (0.05) for the application of statistical tests.

The test of *Wilcoxon Signed Posts* was used in order to verify possible differences between the two observation moments for the variables of interest in each group studied. To verify possible differences between both groups studied for the variables of interest was applied the *Mann-Whitney test*. As we have only four sampling units per group, we can consider that there are effective trends to find differences when 'p' (significance) is between 5% (0.050) and 10% (0,100).

RESULTS

In comparing the mean age presented by the two groups there was no significant difference between them, showing homogeneity between the groups with respect to age (Table 1). Comparing the average of the variables range and time of muscle electrical activity during swallowing saliva and two swallows of paste, no statistically significant differences between groups was observed, both in the comparison of pre-intervention values, as in the post intervention values (Table 1). In the comparison between groups is possible to see tendency to real difference (where $p<0.100$) only in mean comparison in time of the electrical muscle activity during second swallowing of paste food, in the pre-intervention moment time, with highest value for the mean of control group.

In the averages of amplitude and time in muscle electrical activity in the control group (Table 2), there were no significant differences when comparing the pre- and post-intervention. It is verified that the comparisons of the amplitude in muscle electrical activity in saliva swallowing, in the second paste swallowing and time of muscle electrical activity in two offers of paste found values with effective tendency to difference ($p<0.100$).

The average of the range of muscular electrical activity, both in saliva swallowing as the two swallows of paste, were higher in the post-intervention period compared to the pre-intervention period in the control group. However, the average of time muscle electrical activity only were higher in the post-intervention

Table 1. Average of age, range and time of activity electric muscular, pre and post therapeutic intervention according the group studied

Variable	Group	n	$\bar{x}$	SD	Min	Max	Percentile 25	Percentile 50 (Median)	Percentile 75	p
Age	CG	4	70,25	14,77	53,00	84,00	55,50	72,00	83,25	0,245
	EG	4	54,50	14,98	34,00	70,00	39,75	57,00	66,75	
	Total	8	62,38	16,14	34,00	84,00	54,00	60,00	78,25	
AmPre - Saliva (rms)	CG	4	75,84	13,53	59,23	91,11	62,44	76,51	88,57	0,386
	EG	4	95,54	33,15	60,90	126,59	64,08	97,34	125,21	
	Total	8	85,69	25,70	59,23	126,59	63,69	77,29	113,58	
TiPre - Saliva (s)	CG	4	0,81	0,52	0,51	1,58	0,51	0,58	1,35	0,384
	EG	4	0,89	0,45	0,63	1,57	0,64	0,69	1,35	
	Total	8	0,85	0,45	0,51	1,58	0,54	0,66	1,35	
AmPre- Paste1	CG	4	108,42	32,04	67,38	136,00	75,20	115,14	134,91	0,386
	EG	4	91,48	21,60	64,60	114,12	69,65	93,61	111,20	
	Total	8	99,95	26,87	64,60	136,00	71,73	100,54	127,26	
TiPre- Paste1	CG	4	1,42	0,34	1,19	1,92	1,21	1,29	1,77	0,149
	EG	4	0,91	0,42	0,46	1,34	0,51	0,91	1,30	
	Total	8	1,16	0,45	0,46	1,92	0,78	1,23	1,33	
AmPre- Paste2	CG	4	118,61	15,66	101,26	132,77	103,32	120,20	132,30	0,149
	EG	4	88,06	30,29	43,58	110,18	56,45	99,25	108,49	
	Total	8	103,33	27,66	43,58	132,77	96,62	106,46	125,71	
TePre- Paste2	CG	4	1,59	0,82	1,11	2,82	1,12	1,22	2,44	0,083
	EG	4	0,81	0,35	0,44	1,26	0,49	0,77	1,17	
	Total	8	1,20	0,72	0,44	2,82	0,71	1,13	1,29	
AmPost - Saliva (rms)	CG	4	130,24	37,89	81,82	172,37	92,43	133,39	164,91	0,149
	EG	4	93,11	26,45	75,14	132,43	76,78	82,43	120,11	
	Total	8	111,67	36,18	75,14	172,37	81,74	103,70	140,00	
TiPost - Saliva (s)	CG	4	1,05	0,30	0,61	1,27	0,73	1,15	1,25	0,564
	EG	4	0,87	0,48	0,24	1,41	0,40	0,92	1,30	
	Total	8	0,96	0,38	0,24	1,41	0,67	1,04	1,25	
AmPost- Paste1	CG	4	129,49	43,04	87,46	189,30	94,42	120,59	173,45	0,564
	EG	4	111,44	40,85	73,63	153,00	75,03	109,57	149,73	
	Total	8	120,46	40,03	73,63	189,30	81,28	120,59	149,73	
TiPost- Paste1	CG	4	0,67	0,38	0,32	1,16	0,35	0,60	1,07	0,885
	EG	4	0,61	0,40	0,30	1,20	0,33	0,48	1,03	
	Total	8	0,64	0,36	0,30	1,20	0,35	0,48	1,07	
AmPost- Paste2	CG	4	140,64	30,51	111,10	167,68	112,71	141,89	167,32	0,248
	EG	4	113,34	43,31	73,26	153,60	74,60	113,25	152,17	
	Total	8	126,99	37,63	73,26	167,68	86,73	132,72	163,07	
TiPost- Paste2	CG	4	0,55	0,34	0,19	0,93	0,23	0,54	0,88	0,773
	EG	4	0,52	0,17	0,37	0,75	0,39	0,49	0,70	
	Total	8	0,54	0,25	0,19	0,93	0,35	0,49	0,75	

Legend: n= sample; $\bar{x}$ = range; SD=Standard deviation; p= significance; Am= amplitude; Ti= time; CG= control group; EG= experimental group; Min= minimum; Max= maximum.

Mann-Whitney Test. $p<0,05$

moment for saliva swallowing, in this same group (Table 2).

There were no statistical differences in mean values of amplitude and time of electrical muscle activity during swallowing in the pre- and post-intervention the experimental group (Table 3). The comparisons of average in time muscle electrical activity in pre and post intervention in two swallows of paste showed values with effective tendency to difference (p <0.100). In the experimental group, this trend was not found in average in amplitude and time in muscle electrical activity for saliva swallowing and in the average amplitude of electrical muscle activity in swallowing of paste (Table 3).

In the experimental group, only the averages of the muscular electrical activity amplitude values for the two swallows of paste were higher in post-intervention moment than in the pre-intervention (Table 3).

Table 2. Average of age, range and time of activity electric muscular, pre and post therapeutic intervention, in control group

Variables	n	$\bar{x}$	SD	Min	Max	Percentile 25	Percentile 50 (Median)	Percentile 75	p
AmPre - Saliva (rms)	4	75,84	13,53	59,23	91,11	62,44	76,51	88,57	0,068
AmPost - Saliva (rms)	4	130,24	37,89	81,82	172,37	92,43	133,39	164,91	
TiPre - Saliva (s)	4	0,81	0,52	0,51	1,58	0,51	0,58	1,35	0,465
TiPost - Saliva (s)	4	1,05	0,30	0,61	1,27	0,73	1,15	1,25	
AmPre- Paste1	4	108,42	32,04	67,38	136,00	75,20	115,14	134,91	0,465
AmPost- Paste1	4	129,49	43,04	87,46	189,30	94,42	120,59	173,45	
TiPre- Paste1	4	1,42	0,34	1,19	1,92	1,21	1,29	1,77	0,068
TiPost- Paste1	4	0,67	0,38	0,32	1,16	0,35	0,60	1,07	
AmPre- Paste2	4	118,61	15,66	101,26	132,77	103,32	120,20	132,30	0,068
AmPost- Paste2	4	140,64	30,51	111,10	167,68	112,71	141,89	167,32	
TiPre- Paste2	4	1,59	0,82	1,11	2,82	1,12	1,22	2,44	0,068
TiPost- Paste2	4	0,55	0,34	0,19	0,93	0,23	0,54	0,88	

Legend: n= sample; $\bar{x}$ = range; SD=Standard deviation; p= significance; Am= amplitude; Ti= time; Min= minimum; Max= maximum.
Wilcoxon Signed Posts Test. p<0,05

Table 3. Average of age, range and time of activity electric muscular, pre and post therapeutic intervention, in experimental group

Variables	n	$\bar{x}$	SD	Min	Max	Percentile 25	Percentile 50 (Median)	Percentile 75	p
AmPre - Saliva (rms)	4	95,54	33,15	60,90	126,59	64,08	97,34	125,21	0,715
AmPost - Saliva (rms)	4	93,11	26,45	75,14	132,43	76,78	82,43	120,11	
TiPre - Saliva (s)	4	0,89	0,45	0,63	1,57	0,64	0,69	1,35	> 0,999
TiPost - Saliva (s)	4	0,87	0,48	0,24	1,41	0,40	0,92	1,30	
AmPre- Paste1	4	91,48	21,60	64,60	114,12	69,65	93,61	111,20	0,144
AmPost- Paste1	4	111,44	40,85	73,63	153,00	75,03	109,57	149,73	
TiPre- Paste1	4	0,91	0,42	0,46	1,34	0,51	0,91	1,30	0,068
TiPost- Paste1	4	0,61	0,40	0,30	1,20	0,33	0,48	1,03	
AmPre- Paste2	4	88,06	30,29	43,58	110,18	56,45	99,25	108,49	0,144
AmPost- Paste2	4	113,34	43,31	73,26	153,60	74,60	113,25	152,17	
TiPre- Paste2	4	0,81	0,35	0,44	1,26	0,49	0,77	1,17	0,068
TiPost- Paste2	4	0,52	0,17	0,37	0,75	0,39	0,49	0,70	

Legend: n= sample; $\bar{x}$ = range; SD=Standard deviation; p= significance; Am= amplitude; Ti= time; Min= minimum; Max= maximum.
Wilcoxon Signed Posts Test. p<0,05

DISCUSSION

This study investigated the effect of electrical stimulation Neuromuscular (NMES) in the contraction of suprahyoid muscles during swallowing in post-stroke patients with oropharyngeal dysphagia. Both in the group of patients who received intervention of NMES as in the control group were not found values with statistical significance that could prove the improvement of (contraction) muscle electrical activity of these muscles due to therapeutic intervention performed.

According to the data found in this research is not possible to affirm that the use of NMES associated with active exercises or the realization only of the latter, was effective in promoting increased contraction of suprahyoid muscles. Furthermore, neither of the interventions applied showed statistically significant for more efficiency when compared to other intervention.

Although the values found, the authors of this study clinically proven improvement in swallowing functionality, by observing the reduction of clinical signs suggestive of tracheal aspiration, and increased efficiency of swallowing. However, these data are derived from clinical observation, and present considerable subjectivity. In addition, we found that patients in the experimental group showed no new complaints related to swallowing. These findings corroborate those from Beom *et al*.[5] who found that NMES not shown quantitative improvement as assessed by videofluoroscopy in swallowing in patients with dysphagia and reduced laryngeal elevation. However, they found that the patients who received NMES showed qualitative improvement observed through functional scale, compared to the traditional speech therapy. The same authors warn that further studies are needed with more homogeneous control group and high sample, in order to fully establish the effects of NMES in patients with dysphagia.

In this research, in addition to individuals were divided randomly in each group and without the knowledge of the invention to be held, featuring a blind study, there was no statistical difference in age between the control and experimental groups, which features homogeneity between groups. In contrast, the sample with a small number of participants may have been an impeditive factor for statistical significance. In some comparisons of averages was observed a significance trends which may indicate that a larger sample might give statistical significance. However, as these trends were found in both groups, it did not prove the greater therapeutic efficacy of NMES compared to isolated active exercises.

Another factor that in this research could have contributed to not statistical significance refers to the number and frequency of treatment sessions, being realized eight sessions, once a week. There is no consensus in the scientific literature about the number of minimum sessions to produce therapeutic efficiency, but it can be inferred that the increase in the number of sessions or in the frequency of therapy, could produce different results.

Crary and Carnaby[25], in a literature review article, emphasizes the importance of recent publications describing traditional therapy and the contribution of electrostimulation. The authors believe that NMES could play a useful role, as a supporting, to better development of rehabilitation exercises in dysphagia, but are necessary further studies regarding to its impact on the physiological potential of the swallowing mechanism and its functional results.

The scientific literature is controversial in relation to the therapeutic effects of NMES in the rehabilitation of dysphagia. While some studies[1,3,8-16] show benefits in the pathophysiology of swallowing in patients with oropharyngeal dysphagia submitted to NMES, others[5-7] report the absence of physiological and functional changes resulting from these stimuli. It must be said that even the publications that demonstrate positive results present questionable methodological designs in scientific relevance.

The physiological effects that are produced with the use of NMES are influenced, among other things, by the location of the electrodes on the region to be stimulated, by the selection of the frequency of electric stimulus and of the duration of the stimuli during therapy[4]. Thus, according to the anatomical region in which the electrode was inserted and especially according the format of a NMES application protocol, the result arising from therapeutic intervention may be different. There is no homogeneity among the studies that relate the effect of the NMES in the rehabilitation of dysphagia in relation to the positioning of the electrodes and protocols used, thus the difference of results can be explained by these aspects.

The NMES application protocol in this study prioritized the needs of muscle preparation by the application of electric current TENS at the beginning and end of each session, and stimulation of muscle fibers type II with the realization of electric current FES at a frequency of 80Hz . The muscle fibers of type II are

responsible for the "explosion" of muscle contraction and the strength gain, but more susceptible to fatigue[26]. After the data found in this study, the authors have questioned if the electrical stimulation of the muscle fibers type I, through application of FES current with a lower frequency, could result in greater gains in relation to the therapeutic efficiency. This questioning is due to the fact that the muscle fibers type I are more resistant to fatigue[26] and patients in this study were at the beginning of the rehabilitation process, at which usually the muscle condition is more weakness[4].

The verification of efficiency of therapeutic techniques in the rehabilitation of oropharyngeal dysphagia requires the use of evolution indicator that can be clinical aspects, as episodes of pneumonia and weight gain, or quantitative and qualitative measures through scales and objective assessment like video-fluoroscopy and electromyography.

In this study, the verification of NMES efficiency was performed through the use of biofeedback surface electromyography (sEMG-Biofeedback). The same method of measurement was used in another study[27] that evaluated sixty healthy individuals with sEMG-Biofeedback, aiming to check the electrical activity of suprahyoid muscles during swallowing function. The results of this study showed statistically significant differences in electrical activity of suprahyoid muscles in swallowing requested by verbal command and in those that occurred spontaneously. The authors discussed that the sEMG-Biofeedback is a sensitive instrument to the electrical muscle activity (muscle contraction) during swallowing, but questioned the small sample of individuals to establish normal values.

Crary *et al*.[28] performed a study using the sEMG-Biofeedback as a rehabilitation tool, not evaluation, with results indicating that this type of intervention promotes improvement in swallowing function when associated with therapy. Because this instrument is used primarily in rehabilitation, the authors of this study questioned the sensitivity of this in assessing the electrical muscle activity (muscle contraction) during swallowing as a form of assessment in two different moments.

Cola *et al*.[3], in a literature review to verify the effectiveness of the use of NMES in the rehabilitation of oropharyngeal dysphagia concludes that NMES is an effective method in the treatment of dysphagia, with beneficial changes, such as the return of the diet by mouth, reduced episodes of tracheal aspiration, among others. The results show that NMES associated with traditional therapy demonstrates higher effectiveness.

Although lacking consensus in the literature about the efficiency of the use of NMES in the rehabilitation of oropharyngeal dysphagia and data found in this research, clinical practice shows therapeutic benefits with the application of this technique in patients with dysphagia. Thus, further studies are needed with greater uniformity about the location of electrodes, the choice of the evolution indicator and the protocol used for the application of NMES.

CONCLUSION

The use of NMES in parameters and methodology used in this study showed not be effective in promoting greater contraction of suprahyoid muscles during swallowing after stroke in patients with oropharyngeal dysphagia. The findings may be due to the methodology used in this study with regard to technical application protocol and how to measure results.

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